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3-1 TO 3-351



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SERIALS

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PURCHASE OF PUBLICATIONS

Those wishing to purchase items abstracted herein should address their orders to the agency, society, or organization indicated in the bibliographic citations preceding the abstracts, or to their local book dealer. The city and state for the serials cited are given above. The American Geological Institute, publisher of GeoScience Abstracts, regrets that it cannot fill purchase orders for abstracted publications other than its own.

GeoScience Abstracts

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

See also: Areal and Regional Geology 3-62 through 65, 3-68, 3-69; Geomorphology 3-84; Stratigraphy 1-28; Mineral Deposits 3-294, 3-295; Fuels 3-316, 3-319, 3-320; Miscellaneous 3-342.

1. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 1012, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. $46^{\circ}45'-47^{\circ}N.$, long. $61^{\circ}-61^{\circ}30'W.$, 1960.

2. Alberta, Oil and Gas Conservation Board. MAP SHOWING THE PALEOZOIC SURFACE FOR AREA NO. FOUR, ALBERTA: scale 1 in. to 4 mi., 103 Sixth Ave., S.W., Calgary, 1960.

3. Canada, Geological Survey. ANTIGONISH, ANTIGONISH AND GUYSBOROUGH COUNTIES, NOVA SCOTIA: Its: Geophysics Paper 240, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. $45^{\circ}30'-45^{\circ}45'N.$, long. $61^{\circ}0'-62^{\circ}W.$, 1960.

4. Canada, Geological Survey. CAPE GEORGE, ANTIGONISH AND INVERNESS COUNTIES, NOVA SCOTIA: Its: Geophysics Paper 230, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. $45^{\circ}45'-46^{\circ}N.$, long. $60^{\circ}30'-62^{\circ}W.$, 1960.

5. Canada, Geological Survey. CHÉTICAMP, INVERNESS COUNTY, NOVA SCOTIA: Its: Geophysics Paper 1011, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. $46^{\circ}30'-46^{\circ}45'N.$, long. $61^{\circ}-61^{\circ}30'W.$, 1960.

6. Canada, Geological Survey. CHÉTICAMP, INVER, INVERNESS AND VICTORIA COUNTIES, NOVA SCOTIA: Its: Geophysics Paper 1025, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. $46^{\circ}30'-46^{\circ}45'N.$, long. $60^{\circ}30'-61^{\circ}W.$, 1960.

7. Canada, Geological Survey. DINGWALL, VICTORIA COUNTY, NOVA SCOTIA: Its: Geophysics Paper 1014, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. $45^{\circ}45'-47^{\circ}N.$, long. $60^{\circ}-60^{\circ}30'W.$, 1960.

8. Canada, Geological Survey. LAKE ENSLIE, INVERNESS AND VICTORIA COUNTIES, NOVA SCOTIA: Its: Geophysics Paper 1026, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. $46^{\circ}-46^{\circ}15'N.$, long. $60^{\circ}-61^{\circ}30'W.$, 1960.

9. Canada, Geological Survey. MARGAREE, INVERNESS COUNTY, NOVA SCOTIA: Its: Geophysics Paper 1010, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. $46^{\circ}15'-46^{\circ}30'N.$, long. $61^{\circ}-61^{\circ}30'W.$, 1960.

3-10. Canada, Geological Survey. PLEASANT BAY, INVERNESS AND VICTORIA COUNTIES, NOVA SCOTIA: Its: Geophysics Paper 1013, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. $46^{\circ}45'-47^{\circ}N.$, long. $60^{\circ}30'-61^{\circ}W.$, 1960.

3-11. Ontario, Dept. of Mines. BIG DUCK LAKE AREA, DISTRICT OF THUNDER BAY: Its: Prelim. Map no. P.87, scale 1 in. to 1/4 mi., 1960.

Accompanying this preliminary geologic map is a 2-p. legend and list of mineral deposits.

3-12. Ontario, Dept. of Mines. LEROCHE TOWNSHIP, DISTRICT OF NIPISSING: Its: Prelim. Map P.74, scale 1 in. to 1/4 mi., 1960.

Accompanying this preliminary geologic map and the maps of Cynthia, Belfast, Joan, and Phyllis townships (see abstracts immediately below) is a 3-p. explanatory text, Notes on the Geology of LeRoche, Cynthia, Belfast, Joan and Phyllis Townships, District of Nipissing, by P. S. Simony. Text includes the legend for the maps.

3-13. Ontario, Dept. of Mines. CYNTHIA TOWNSHIP, DISTRICT OF NIPISSING: Its: Prelim. Map P.75, scale 1 in. to 1/4 mi., 1960.

3-14. Ontario, Dept. of Mines. BELFAST TOWNSHIP, DISTRICT OF NIPISSING: Its: Prelim. Map P.76, scale 1 in. to 1/4 mi., 1960.

3-15. Ontario, Dept. of Mines. JOAN TOWNSHIP, DISTRICT OF NIPISSING: Its: Prelim. Map P.77, scale 1 in. to 1/4 mi., 1960.

3-16. Ontario, Dept. of Mines. PHYLLIS TOWNSHIP, DISTRICT OF NIPISSING: Its: Prelim. Map P.78, scale 1 in. to 1/4 mi., 1960.

3-17. Ontario, Dept. of Mines. COBDEN TOWNSHIP, DISTRICT OF ALGOMA, ONTARIO: Its: Prelim. Map no. P.71, scale 1 in. to 1/4 mi., [1960].

3-18. Irvine, Thomas N., and others. LAC DES MILLE LACS AREA (WEST HALF), DISTRICT OF THUNDER BAY, ONTARIO: Ontario, Dept. Mines, Prelim. Map no. P-88, scale 1 in. to 1/2 mi., approx. lat. $48^{\circ}42'-48^{\circ}55'N.$, long. $90^{\circ}35'-90^{\circ}58'W.$, 1960.

3-19. Ontario, Dept. of Mines. LONG TOWNSHIP, DISTRICT OF ALGOMA, ONTARIO: Its: Prelim. Map no. P.73, scale 1 in. to 1/4 mi., [1960].

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3-21. Ontario, Dept. of Mines. MACK TOWNSHIP, DISTRICT OF ALGOMA, ONTARIO: Its:

Prelim. Map no. P.69, scale 1 in. to 1/4 mi., [1960].

3-22. Ontario, Dept. of Mines. SCARFE TOWNSHIP, DISTRICT OF ALGOMA, ONTARIO: Its: Prelim. Map no. P. 68, scale 1 in. to 1/4 mi., approx. lat. $46^{\circ}15'-46^{\circ}22'N.$, long. $82^{\circ}58'-83^{\circ}05'W.$, 1960.

3-23. Ontario, Dept. of Mines. STRIKER TOWNSHIP, DISTRICT OF ALGOMA, ONTARIO: Its: Prelim. Map no. P.72, scale 1 in. to 1/4 mi., [1960].

3-24. Canada, Geological Survey, and Ontario, Dept. of Mines. ACHAPI LAKE, THUNDER BAY AND KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 932, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $51^{\circ}-51^{\circ}15'N.$, long. $89^{\circ}30'-90^{\circ}W.$, 1960.

3-25. Canada, Geological Survey, and Ontario, Dept. of Mines. BIG BEAVER HOUSE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 939, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $52^{\circ}45'-53^{\circ}N.$, long. $89^{\circ}30'-90^{\circ}W.$, 1960.

3-26. Canada, Geological Survey, and Ontario, Dept. of Mines. BURNTROCK LAKE, THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 931, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $50^{\circ}45'-51^{\circ}N.$, long. $89^{\circ}30'-90^{\circ}W.$, 1960.

3-27. Canada, Geological Survey, and Ontario, Dept. of Mines. COLLISHAW LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 934, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $51^{\circ}30'-51^{\circ}45'N.$, long. $89^{\circ}30'-90^{\circ}W.$, 1960.

3-28. Canada, Geological Survey, and Ontario, Dept. of Mines. CRERAR LAKE, KENORA AND THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 944, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $51^{\circ}30'-51^{\circ}45'N.$, long. $89^{\circ}-89^{\circ}30'W.$, 1960.

3-29. Canada, Geological Survey, and Ontario, Dept. of Mines. DILLEN LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 936, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $52^{\circ}-52^{\circ}15'N.$, long. $89^{\circ}30'-90^{\circ}W.$, 1960.

3-30. Canada, Geological Survey, and Ontario, Dept. of Mines. EYES LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 957, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $52^{\circ}15'-$

$52^{\circ}30'N.$, long. $88^{\circ}30'-89^{\circ}W.$, 1960.

3-31. Canada, Geological Survey, and Ontario, Dept. of Mines. GOLDSBOROUGH LAKE, THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 940, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $50^{\circ}30'-50^{\circ}45'N.$, long. $89^{\circ}-89^{\circ}30'W.$, 1960.

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3-33. Canada, Geological Survey, and Ontario, Dept. of Mines. GREENMANTLE LAKE, THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 942, aeromagnetic map, scale 1:63,360, contour intervals, 10, 20, 100, and 1000 gammas, lat. $51^{\circ}-51^{\circ}15'N.$, long. $89^{\circ}-89^{\circ}30'W.$, 1960.

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3-37. Canada, Geological Survey, and Ontario, Dept. of Mines. LYSANDER LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 935, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $51^{\circ}45'-52^{\circ}N.$, long. $89^{\circ}30'-90^{\circ}W.$, 1960.

3-38. Canada, Geological Survey, and Ontario, Dept. of Mines. MICHIKENIS LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 948, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $52^{\circ}30'-52^{\circ}45'N.$, long. $89^{\circ}-89^{\circ}30'W.$, 1960.

3-39. Canada, Geological Survey, and Ontario, Dept. of Mines. MIMINISKA LAKE, KENORA AND

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- THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 954, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $51^{\circ}30'-51^{\circ}45'N.$, long. $88^{\circ}30'-89^{\circ}W.$, 1960.
40. Canada, Geological Survey, and Ontario, Dept. of Mines. NEAWAGANK LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 937, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $52^{\circ}15'-52^{\circ}30'N.$, long. $89^{\circ}30'-90^{\circ}W.$, 1960.
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42. Canada, Geological Survey, and Ontario, Dept. of Mines. OZHISKI LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 955, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $50^{\circ}45'-52^{\circ}N.$, long. $88^{\circ}30'-89^{\circ}W.$, 1960.
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45. Canada, Geological Survey, and Ontario, Dept. of Mines. SEACH LAKE, KENORA AND THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 933, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $51^{\circ}15'-51^{\circ}30'N.$, long. $89^{\circ}-90^{\circ}W.$, 1960.
46. Canada, Geological Survey, and Ontario, Dept. of Mines. SENNETT LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 959, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $52^{\circ}45'-53^{\circ}N.$, long. $88^{\circ}30'-89^{\circ}W.$, 1960.
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- 3-48. Canada, Geological Survey, and Ontario, Dept. of Mines. TOTOGAN LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 946, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $52^{\circ}-52^{\circ}15'N.$, long. $89^{\circ}-89^{\circ}30'W.$, 1960.
- 3-49. Canada, Geological Survey, and Ontario, Dept. of Mines. WABAKIMI LAKE, THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 930, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $50^{\circ}30'-50^{\circ}45'N.$, long. $89^{\circ}30'-90^{\circ}W.$, 1960.
- 3-50. Canada, Geological Survey, and Ontario, Dept. of Mines. WHITECLAY LAKE, THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 941, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $50^{\circ}45'-51^{\circ}N.$, long. $88^{\circ}30'-89^{\circ}W.$, 1960.
- 3-51. Canada, Geological Survey, and Ontario, Dept. of Mines. WHITEWATER LAKE, THUNDER BAY DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 941, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $50^{\circ}45'-51^{\circ}N.$, long. $89^{\circ}-89^{\circ}30'W.$, 1960.
- 3-52. Canada, Geological Survey, and Ontario, Dept. of Mines. WIGWASCENCE LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 947, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $52^{\circ}15'-52^{\circ}30'N.$, long. $89^{\circ}-89^{\circ}30'W.$, 1960.
- 3-53. Canada, Geological Survey, and Ontario, Dept. of Mines. WUNNUMMIN LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 949, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. $52^{\circ}45'-53^{\circ}N.$, long. $89^{\circ}-89^{\circ}30'W.$, 1960.
- 3-54. U.S. Geological Survey. GRAND CANYON NATIONAL PARK, ARIZONA (EAST HALF): scale 1:48,000, contour interval 50 ft., lat. $35^{\circ}57'35''-36^{\circ}25'N.$, long. $111^{\circ}45'-112^{\circ}15'W.$, 1902-1923, re-printed 1960.
- 3-55. Jennings, Charles W., and Rudolph G. Strand, comps. GEOLOGIC MAP OF CALIFORNIA: UKIAH SHEET: California, Div. Mines, 2 sheets: geol. map, strat. nomenclature, scale 1:250,000, contour intervals 100 and 200 ft., 5 illus., 1960, 21 refs.

The sixth sheet of the Olaf P. Jenkins edition of the geologic map of California covers the area $39^{\circ}-40^{\circ}N.$ $122^{\circ}-124^{\circ}W.$ It indicates in color the geology of the area of northern California bounded by the Sacramento Valley on the E. and the Pacific Ocean on the W., extending from Clear Lake on the S. to Corn-
ing on the N.

Thirty-one of the state geologic map units appear on the Ukiah Sheet: 13 Quaternary, 4 Pliocene, 1 each of Miocene, Eocene, Paleocene, and undivided Tertiary, 5 Cretaceous, 2 Jurassic, and 2 pre-Cretaceous. Marine sedimentary, nonmarine sedimentary, volcanic, and intrusive rocks are differentiated.

Accompanying the map is a sheet containing a chart and list of references showing the reports and maps used in compilation of the Ukiah sheet, a table of stratigraphic nomenclature and lithologic characteristics, an index map showing the U.S. Geological Survey topographic maps covering the area, and 3 photographs. The geologic map is also available without the geologic color overprint.--Auth.

3-56. Merewether, E. Allen, comp. GEOLOGIC MAP OF THE IGNEOUS AND METAMORPHIC ROCKS OF COLORADO SHOWING LOCATION OF URANIUM DEPOSITS: U.S. Geol. Survey, Misc. Inv. Map I-309, scale 1:500,000, lat. 37° - 41° N., long. 102° - 109° W., 1960.

3-57. Merewether, E. Allen, comp. GEOLOGIC MAP OF THE IGNEOUS AND METAMORPHIC ROCKS OF MONTANA SHOWING LOCATION OF URANIUM DEPOSITS: U.S. Geol. Survey, Misc. Inv. Map I-311, 2 sheets, scale 1:500,000, lat. 45° - 49° N., long. 104° - 115° W., 1960.

3-58. Bromery, Randolph W., and others. AEROMAGNETIC MAP OF PART OF THE AMBER QUADRANGLE, MONTGOMERY AND BUCKS COUNTIES, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-265, lat. $40^{\circ}07'30''$ - $40^{\circ}15'N.$, long. $75^{\circ}07'30''$ - $75^{\circ}15'W.$, 1960.

3-59. Gower, Howard D. GEOLOGY OF THE PYSHT QUADRANGLE, WASHINGTON: U.S. Geol. Survey, Geol. Quad. Map GQ-129, scale 1:62,500, contour interval 80 ft., lat. 48° - $48^{\circ}15'N.$, long. 124° - $124^{\circ}15'W.$, 1960.

The map shows the geology of an area of about 170 sq. mi. on the N. coast of the Olympic Peninsula. More than 35,000 ft. of sedimentary and volcanic rocks, ranging in age from Cretaceous (?) to Miocene are exposed. Part of the area is covered by alpine and continental glacial deposits.--U.S. Geol. Survey.

3-60. U.S. Geological Survey. NISQUALLY GLACIER, WASHINGTON: scale 1:9,600, contour interval 50 ft., 1931-1946, reprinted 1960.

3-61. Merewether, E. Allen, comp. GEOLOGIC MAP OF THE IGNEOUS AND METAMORPHIC ROCKS OF WYOMING SHOWING LOCATION OF URANIUM DEPOSITS: U.S. Geol. Survey, Misc. Inv. Map I-310, scale 1:500,000, lat. 41° - 45° N., long. 104° - 111° W., 1960.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Stratigraphy 3-128; Mineral Deposits 3-295; Fuels 3-317, 3-321, 3-329.

3-62. Fahrig, W. F. SHABOGAMO LAKE, NEW-FOUNDLAND AND QUEBEC: Canada, Geol. Survey, Paper 60-9, 4 p., Map 9-1960 (in pocket), scale 1:253,440, 1960.

The mineralogy of the gneisses, quartzites, Fe-formations, and arenaceous rocks of the region are described in detail. The gneissic rocks are a continuation of high-grade metamorphic rocks similar in origin and composition to the more common granitoid gneisses of the Canadian Shield. Clastic sediments may reflect later Grenville mountain building and uplift. Most of the prominent ridges are gabbro in the form of sills or dikes, rather than as irregular massifs. Study of the gabbros and amphibolite layers suggests a Grenville age for the Shabogamo gabbros. The biotite in the pegmatite veins and metasedimentary gneisses is believed to have formed during regional metamorphism of Grenville age, 1 of at least 2 periods of metamorphism. It is likely that most or all of the contacts between the gneisses and younger strata are normal faults resulting from relaxation terminating the Grenville deformation. Strong E.-northeasterly fold pattern is also a continuation of the Grenville deformation. Most of the gneissic rocks are unlikely to be sites of base-metal accumulation.--M. Stewart.

3-63. Douglas, R. J. W., and A. W. Norris. HORN RIVER MAP-AREA, NORTHWEST TERRITORIES: Canada, Geol. Survey, Paper 59-11, 23 p., Map 48-1949 (in pocket), scale 1:506,880, 1960, 14 refs.

Area is underlain by Precambrian rocks of the Canadian Shield and by Ordovician, Devonian, and Cretaceous rocks of the Interior Plains. The bedrock, particularly of the plains, is overlain by a mantle of glacial deposits. Low relief in much of the region is possibly a peneplain. Irregular hills and linear ridges rise as monadnocks above the peneplain surface. Since these were present as islands in Paleozoic seas, their distribution may be very important in oil and gas potentialities.

The rocks are described and mapped, using existing formational nomenclature or numbered map-units. Several Paleozoic formations may contain potential reservoir rocks. Gypsum outcrops at several localities, and there are abundant salt casts.--M. Stewart.

3-64. Douglas, R. J. W., and D. K. Norris. FORT LIARD AND LA BICHE MAP-AREAS, NORTHWEST TERRITORIES AND YUKON: Canada, Geol. Survey, Paper 59-6, 23 p., Maps 31-1959 and 32-1959 (in pocket), scale 1:253,440, 1959, 9 refs.

The eastern part of Fort Liard map-area lies within the Interior Plains, bounded W. of Liard River by the Yukon Plateau of the Mackenzie Mountains. La Biche map-area and western part of Fort Liard embrace the greater part of Liard Plateau which forms the southern part of the Mackenzie Mountains. Rocks ranging in age from Proterozoic(?) to Upper Cretaceous occur; Cretaceous rocks underlie the plains and occupy synclinal basins and troughs in the more mountainous folded part of the region. Paleozoic rocks are exposed in the mountain ranges and along parts of the main rivers. Existing formations and numbered map-units are used for mapping and descriptive purposes. Several structures and features of the stratigraphic succession appear favorable for petroleum and natural gas, and several wells have been drilled in the area. Main structural features are described in some detail.--P. Harker.

3-65. Thomson, Robert. PRELIMINARY REPORT ON PARTS OF COLEMAN TOWNSHIP AND

GILLIES LIMIT TO THE SOUTH & SOUTHWEST OF COBALT, DISTRICT OF TIMISKAMING: Ontario, Dept. Mines, Prelim. Rept. 1960-3, 80 p., provisional maps P-79, P-80, P-81, P-82, P-83 (separate), scale 1 in. to 400 ft., table, Nov. 1960, refs.

Geological notes on the areas covered by the map sheets and descriptions of mining properties are given. The area covered by each map is treated separately, except for those covered by Maps P. 82 and P. 83, which are treated together.

3-66. Hudson, Frank S. POST-PLIOCENE UPLIFT OF THE SIERRA NEVADA, CALIFORNIA: Geol. Soc. America, Bull., v. 71, no. 11, p. 1547-1573, 2 maps, diag., graph, 7 profiles, 8 tables, Nov. 1960, 29 refs.

Matthes determined the position of 3 ancestral stages of the upper Merced River by projecting the gradients of hanging-valley tributaries to points above the present main stream. From the gradients of the 2 older stages he concluded that the Sierra Nevada range had been tilted westward, resulting in 9,000 ft. of uplift of the range crest at the head of the river, since the establishment in late Miocene time of the oldest, broad-valley, stage. Axelrod's work, based on paleobotany, indicates that at Granite Chief, on the summit of the range, about 100 mi. N. of the Merced River, the uplift has been about 5,505 ft. since late Miocene time.

In a redetermination of the old Merced channels by Matthes' method, the broad-valley stream is traced to the western edge of the range and thence into the ancestral San Joaquin Valley, by way of a pediment. A new calculation of the amount of tilting undergone by the range since broad-valley time, now considered early Pleistocene, is based on the assumption that certain well-graded stretches of the ancient stream had pretilt slopes equal to those of subjacent, well-graded parts of the modern river. The amount of tilting in the pediment region is determined by conventional geologic methods. The calculations indicate that the summit of the range, at the head of the Merced River, has been raised only 3,930 ft. since broad-valley (= early Pleistocene) time. The same methods applied to the Middle Fork of American River indicate that the contemporaneous uplift at Granite Chief was 2,054 ft. Results of calculations made by other physical methods indicate the uplift at this place to have been between 2,289 and 2,745 ft. since middle Eocene time and 1,946 ft. since the early Pliocene.--Auth.

3-67. Jillson, Willard Rouse. GEOLOGY OF THE GOOSE CREEK DOME IN CASEY AND RUSSELL COUNTIES, KENTUCKY: 88 p., 21 illus., 3 maps, 3 profiles, 9 secs., diag., Frankfort, Kentucky, Perry Publishing Co., 1960, 14 refs.

The Goose Creek dome and faults occupy an elongate area of about 15 sq. mi. marked geographically in the central southern part of the state by the cross-roads village of Dunnville, Kentucky. Goose Creek, a N.-flowing tributary of the upper Green River, courses through an area of rugged terrain properly described as one of mature dissection, the highest plateau levels of which range from 1,100 to 1,130 ft. A.T., and debouches onto a broad flood plain of the master stream which it joins at 720 ft. A.T. The maximum topographic relief is therefore 410 ft.

The exposed stratigraphic section involves Paleozoic sedimentary rocks, limestones, sandstones

and shales ranging upwardly from the middle Richmond (Upper Ordovician) to the St. Louis (middle Mississippian) and, excluding the Silurian which is entirely absent, has a total thickness of about 505 ft. This coupled with an overlay of stream alluvium varying from 0 to 15 ft., produces an entire exposed rock section of about 520 ft. in thickness. An original overriding hard rock section ranging upwardly from the St. Louis to and into the Pottsville (Lower Pennsylvanian) of about 750 ft. in thickness is seen as having been removed by erosion and solution from this area prior to mid-Tertiary (late Miocene) penetration of which the present day ridgetops are vestigial.

The Goose Creek dome, in pattern an ovalate uplift, is located structurally near the crest of the Cincinnati arch and apparently is closely associated with it in origin. It has about 150 ft. of closure. The Goose Creek faults are normal in character, 2 in number, nearly parallel in strike - N. 10° E. - over much of their course and enclose a well defined, deep set graben ranging in width from 2,000 ft. on the N. to more than 5,000 ft. on the S. The West fault is the major disturbance in length 13 mi. or more and in displacement 350 ft. at approximately the medial point of maximum throw. Three cross faults are certain of occurrence.

Some 36 or more wells have been drilled for oil and gas on and in the vicinity of the Goose Creek dome and faults. Green oil of medium to comparatively high gravity has been found, produced, and sold from a number of these wells for several years up to and including 1959. Oil producing formations range from shallow (592 ft.) to medium deep (1,731 ft.) depending upon topographic and structural location and exploratory objective. Oil production has been obtained from 4 horizons, 2 in the lower Trenton in the range of the lower Sunnybrook, 1 in the Tyrone approximating the Modoc, and 1 in the upper Knox. Because of operating and financing difficulties, lease blocks which appear to afford the best locations in this largely undeveloped field have only been lightly indexed up to the present time. Certain areas on the Goose Creek dome very apparently have real merit and amply justify additional exploratory drilling to all oil producing formations.--From auth. resume.

3-68. Ross, Clyde P. GEOLOGY OF GLACIER NATIONAL PARK AND THE FLATHEAD REGION, NORTHWESTERN MONTANA: U.S. Geol. Survey, Prof. Paper 296, 125 p., 40 illus., 6 maps (4 col. in pocket), diag., 1959, 153 refs.

This report summarizes data on Glacier National Park, Montana, and the region S. of it. The principal economic value is as a collecting ground for snow to supply water used in surrounding lowlands and as a scenic and wildlife recreation area.

The rocks range from Precambrian to Recent. The Belt series of Precambrian age include in ascending order, Altyn limestone (dolomite), Appekunny argillite, Grinnell argillite, Siyeh limestone, and Missoula group, totaling over 25,000 ft. in thickness. Small gabbroic and diabasic intrusions and some basaltic lava are associated with the series. The stromatolites in the series give clues with respect to problems of ecology and stratigraphy. Belt series is overlain by Cambrian, Devonian, Carboniferous, Jurassic, and Cretaceous strata, partly of terrestrial origin. Poorly consolidated Tertiary and younger rocks are present in valleys. Minor crustal movements occurred in Belt time and there was

broad warping during the Paleozoic and Mesozoic eras. Mountain building may have begun during the Cretaceous. In and shortly after the Paleocene, major thrusts and normal faults preceded and accompanied by folds and minor fractures were developed. The principal structure, the Lewis overthrust, is thought to have originated deep in the crust and moved many miles in a NE. direction over relatively incompetent crumpled rocks. The block above the thrust was less intensely deformed.

The late Tertiary Blackfoot erosion surface has been intricately carved, in part during several glacial stages.--Auth.

3-69. Wildden, Ronald. GEOLOGY OF THE JACKSON MOUNTAINS, HUMBOLDT COUNTY, NEVADA: U.S. Geol. Survey, Repts., Open-File Ser., no. 587, 20 p., 24 illus., 6 maps (1 col. geol. map in pocket, scale 1:62,500), 10 secs. (3 col. in pocket), 2 charts, 3 profiles, 4 tables, 1960, 36 refs.

The Jackson Mountains, a prominent range near the center of Humboldt County, are of interest because the Cretaceous rocks in the range record the effects of a late Cretaceous to early Tertiary orogeny. Such an orogeny has been assumed to have affected all of the Great Basin, but the rock record is sufficiently complete to provide positive dating in only a few areas such as the Jackson Mountains.

The oldest rocks in the range are the Permian and older(?) volcanic rocks of the Happy Creek volcanic series which make up most of the northern half of the range. In a few places the Happy Creek volcanic series grades upward into undivided Permian and Triassic rocks, which consist of interbedded clastic sedimentary rocks and basic volcanic rocks, with some shaly and siliceous limestone. The Happy Creek volcanic series is also overlain by an unnamed predominantly limestone unit of Triassic age. A phyllite and slate unit of probable Triassic age is in fault contact with the Permian and Triassic undivided rocks. At several other localities the Happy Creek volcanic rocks are overlain by the early Cretaceous King Lear formation or by the Cretaceous or Tertiary Pansy Lee conglomerate, which are the 2 units of chief importance in dating the Cretaceous and early Tertiary orogenic events.

The King Lear formation consists of locally derived pebble and boulder conglomerate and interbedded siltstone and graywacke, and lenses of limestone.

The Pansy Lee conglomerate is a pebble conglomerate with considerable interbedded coarse-grained sandstone. The pebbles consist of chert and quartzite completely unlike rocks now exposed in the Jackson Mountains.

Dioritic rocks were intruded both before and after the King Lear formation was deposited. Granodioritic intrusive bodies in the range cut rocks no younger than Triassic but the granodiorite is believed to be of late Cretaceous or early Tertiary age.

Tertiary intrusive and extrusive volcanic rocks and sedimentary rocks are widely distributed along the E. side and S. end of the range.

The most extensive tectonic feature of the Jackson Mountains is the Deer Creek thrust, which is discontinuously exposed from Rattlesnake Canyon northeastward to the N. side of Deer Creek Peak. The thrust has brought the Happy Creek volcanic series over the King Lear and Pansy Lee formations, and thus it is of late Cretaceous or early Tertiary age.

An earlier period of Cretaceous deformation is

shown by a northeastward-plunging syncline in the King Lear formation on the SE. side of King Lear Peak.

Pre-Cretaceous deformation is shown by a tight fold in limestone of the undivided Permian and Triassic unit beneath the King Lear formation at the mouth of Rattlesnake Canyon.

The late Tertiary deformation was almost exclusively a response to vertically directed stresses, which generally produced high-angle faults rather than folds. The range has probably been uplifted principally by displacement on faults that are buried beneath the alluvium some distance to the E. and W. of the range.

Ore deposits in the range include some small but high-grade Fe deposits, some low-grade Hg deposits, and some small Cu prospects.

The Fe occurs in veins that cut the Happy Creek volcanic series or as replacement bodies near the contact between diorite and the Happy Creek volcanics. Bleached volcanic rocks that are cut by numerous closely spaced joints with a film of hematite in the volcanic rock on either side of the joints suggest that the Fe of the Fe deposits has been derived from the Happy Creek volcanic rocks. The diorite intrusives may have provided heat and solutions to mobilize the Fe of the volcanic rocks.--Auth.

3-70. Webb, Frank S. SURFACE GEOLOGY OF THE EUFAULA-TEXANNA AREA, MCINTOSH AND PITTSBURG COUNTIES, OKLAHOMA: Shale Shaker, v. 10, no. 8, p. 2-14, 6 illus., secs., 2 maps, Apr. 1960, 26 refs.

A geologic map of the Eufaula-Texanna area, showing distribution of outcrops and structural relationships, accompanies this report. Rocks that crop out in the area are of Pennsylvanian age with members of the McAlester, Savanna, and Boggy formations represented. Terrace deposits of possible Pleistocene age cover a large part of the Eufaula-Texanna area.

Structural features mapped include the Porum syncline, the S. fault of the Warner uplift, the fault which cuts the S. flank of the Porum syncline, a small syncline in the southeastern part of T. 9 N. R. 17 E., and 2 small anticlines.

The lithologic characters of the rocks indicate a shallow water environment of deposition with periods of emergence, local channeling, swampy conditions, and the formation of coals.--C. E. Branham.

3-71. Crosby, Gary W. GEOLOGY OF THE SOUTH PAVANT RANGE, MILLARD AND SEVIER COUNTIES, UTAH: Brigham Young Univ. Research Studies, Geology Ser., v. 6, no. 3, 59 p., illus., 4 maps (1 fold.), 8 secs., 5 diags., table, Aug. 1959, 46 refs.

The S. end of the Pavant Mountains is situated 160 mi. S. of Salt Lake City between U.S. Highways 91 and 89, and immediately S. of Kanosh in the SE. corner of Millard County, Utah. The Pavant Range is situated astride the boundary between the Basin and Range and Colorado Plateau provinces.

A complete section of sedimentary rocks, representing every period since Precambrian time, is exposed in the S. end of the Pavant Range. In general, Paleozoic strata aggregating 10,122 ft. are similar to units described in the Great Basin, though somewhat thinner, and reflect a shelf to proximal miogeosynclinal depositional environment. Mesozoic-Cenozoic sediments are continuous with strati-

graphic units of the Colorado Plateau, but lithologies reveal diverse depositional environments.

Extrusive volcanics, which spread N. from the Marysville area during late Tertiary time, cover much of the S. end of the Pavant Mountains. Various types include rhyolite, quartz latite, agglomerate, tuff, and basalts. Volcanics of the Mount Belknap series, mostly rhyolite, cover the S. end of the area investigated.

The Pavant overthrust fault places Cambrian quartzites and carbonates on top of Jurassic sandstone. Minimum displacement along this fault is 15 mi. and the southern edge of the upper plate probably lies within the mapped area. Normal faulting is a common structural feature in the range, especially along the W. face.

S, fluorspar, and minor base metals, genetically associated with intrusives in the Tushar Range immediately to the S., occur as vein minerals of commercial grade in the area.--Auth.

3-72. Bick, Kenneth F. GEOLOGY OF THE LEXINGTON QUADRANGLE, VIRGINIA: Virginia, Div. Mineral Resources, Rept. Inv. 1, 40 p., pl., table, 1960, 17 refs.

• The rocks of the Lexington quadrangle, Virginia (bounded by parallels 37°45' and 38°00' and meridians 79°15' and 79°30') range in age from Precambrian to Middle Devonian. The metamorphic and igneous Precambrian basement is overlain by 2,500 ft. of clastic rocks that contain interbedded volcanic material in the basal part; these rocks, Precambrian and Early Cambrian in age, represent a westward transgression of a sea across the area. This sequence is overlain by 10,000 ft. of Early Cambrian to Middle Ordovician rocks, chiefly carbonate rocks that represent a period of offshore shallow water deposition. The Middle Ordovician to Middle Devonian sequence is composed largely of clastic rocks about 4,500 ft. thick; the lower half of this sequence is chiefly sandstone and the upper half is chiefly shale. These clastic rocks represent debris eroded from mountainous areas E. of the Lexington quadrangle.

Deformation of the rocks of the Lexington quadrangle occurred during the Appalachian orogeny of Permian age. The area may be conveniently divided into 3 structural units which correspond closely to the physiographic divisions; the Blue Ridge belt is characterized by folding and faulting of the Precambrian basement rocks; the central belt is characterized by low angle overthrust faulting of sedimentary rocks; and the northwestern belt is characterized by folding of the sedimentary rocks. The Blue Ridge belt is in fault contact with the rocks of the central belt along the Midvale fault and the previously unmapped South River fault. The major thrust faults of the central belt are the North Mountain fault, the Pulaski fault, and the Pulaski-Staunton fault. The North Mountain fault divides into 3 branches in the northern part of the quadrangle and a large window in the upper plate is present SW. of Brownsburg. The Pulaski fault branches SW. of Fairfield; the W. branch is continuous with the Staunton fault and is herein named the Pulaski-Staunton fault; the minor E. branch, formerly thought to be the main Pulaski fault, is named the Fairfield fault. The major structures of the northwestern belt are folds; one fold is overturned and thrust northwestward along the previously unmapped Zack fault in the northern part of the quadrangle. The structural history is a record of long continued deformation that progressed from folding

of sedimentary rocks to overthrust faulting of sedimentary rocks, and finally to faulting of the Blue Ridge anticlinorium over the earlier formed structures.

Fe ore and Mn ore have been mined in the quadrangle from residual accumulations overlying the Rome formation and the Ridgeley sandstone; undiscovered deposits may exist, but they are likely to be small. The quadrangle contains ample supplies of carbonate rocks that may be used for many industrial purposes.--Auth.

3-73. Rod, Emile. GEOLOGIC RECONNAISSANCE OF UPPER YAPACANI RIVER, BOLIVIA: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 11, p. 1818-1828, 5 maps, 4 secs., Nov. 1960, 8 refs.

In the headwaters of Rio Yapacani, a tributary of Rio Mamoré of N.-central Bolivia, a rather complete stratigraphic section from the Tertiary Chaco group down to the quartzites of the Ordovician is exposed. The area of the upper Yapacani lies in the center of the big knee-bend in the Subandean zone which was caused by large left-lateral displacements along the postulated Ichilo fault zone. A well developed, left-lateral strike-slip fault, named the Colorado fault, cutting across the Yapacani valley, is interpreted as the southern branch of the Ichilo fault zone. The Ichilo fault zone might be the western part of a transcontinental zone of disturbance, the eastern part of which could probably be represented by the Posadas-Torres Geoklase reported from the state of Rio Grande do Sul in Brazil.--Auth.

3-74. Gorsky, V.P. ON THE STRATIGRAPHY AND STRUCTURE OF THE CHELYA' BINSK LIGNITE BASIN: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 39-42, Jan-Feb., 1959, pub. Apr. 1960, 7 refs.

New data from deep boreholes require revision of the previous ideas on the stratigraphy and structure of the Chelyabinsk lignite basin. The eastern and western belts of workable coal beds are now considered to belong to 2 different cycles of sedimentation. The basin is considered to have been formed contemporaneously with the deposition of the Rhaetic-Liassic sediments, but fracturing of the structure occurred later in late Jurassic or early Cretaceous time.--F. Manheim.

3-75. Swartz, Daniel H., and Daniel D. Arden, Jr. GEOLOGIC HISTORY OF RED SEA AREA: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 10, p. 1621-1637, 9 maps, Oct. 1960, 25 refs.

The Red Sea depression has been considered by previous workers to be 1) a graben, with down-dropped center block, resulting from compressive forces, or 2) a paar, or depression caused by the moving apart of 2 crustal blocks, and thus essentially a tensional feature. It is to the second hypothesis that the present writers subscribe. It is suggested that movement took place between 4 blocks: Block 1, NE. Africa W. of Suez-Red Sea and N. of the Ethiopian rift valley; Block 2, the Arabian peninsula; Block 3, the Sinai peninsula; and Block 4, the "Horn of Africa" E. of the rift valleys. All of the structural features of the region may be related to various movements between these blocks including the Gulf of Aden, the rift valleys of Ethiopia, the Dead Sea depression, and the mountains of the Levant.

During the Mesozoic the most important movements were epeirogenic. Faulting and volcanism occurred in the Jurassic and Cretaceous. By the end of lower Eocene time compressional stresses developed in the northern regions, while there were tensional forces in the S. It was probably then that the Gulf of Suez-Red Sea pair opened and folds appeared in the Levant. At the southern end of the Red Sea there was strong NW.-SE. faulting accompanied by basalt extrusion in the Ethiopian rifts. Folding

and faulting in the northern region were accompanied by one or more periods of epeirogenic uplift which caused unconformities at the end of lower Eocene, middle Eocene, and Oligocene time.

Beginning in the lower Miocene, the "Horn of Africa" began to separate from the Arabian peninsula. This separation became complete as the Arabian block moved toward the Tethys geosyncline, and during the Pliocene the Red Sea and Gulf of Aden were joined.--Auth.

2. GEOMORPHOLOGY

See also: Structural Geology 3-95; Geohydrology 3-285.

3-76. Post, Austin S. THE EXCEPTIONAL ADVANCES OF THE MULDROW, BLACK RAPIDS, AND SUSITNA GLACIERS: Jour. Geophys. Research, v. 65, no. 11, p. 3703-3712, 3 maps, 2 profiles, 2 diags., table, Nov. 1960, 8 refs.

Muldrow Glacier in Alaska advanced extremely rapidly during the winter of 1956-1957, with surface movements of ice amounting to over 6.6 km. This flow was accompanied by a pronounced lowering of the surface of the upper portion of the glacier by 170 m., or more, with a corresponding rise in surface ice levels in the terminal portion; the net exchange of ice is roughly computed to be equal. No other glacier in the region showed evidence of a similar movement during the same period. However, the Black Rapids Glacier in 1937, the Yanert in 1942, and the Susitna in 1953, did make advances of a similar nature. Unusual medial moraines indicate that at least 2 of these glaciers have previously alternated between stagnation and sudden, brief movements. No evidence was found to suggest short-term climatic conditions favorable to large snow accumulation on these glaciers prior to their advances. Correlation between local earthquakes and these ice movements is also lacking. Evidence does indicate that these advances result from critical dynamic conditions met with in certain glacier systems favoring long periods of stagnation followed by sudden displacements of ice.--Auth.

3-77. Richmond, Gerald M. GLACIATION OF THE EAST SLOPE OF ROCKY MOUNTAIN NATIONAL PARK, COLORADO: Geol. Soc. America, Bull., v. 71, no. 9, p. 1371-1381, map, table, Sept. 1960, 16 refs.

The eastern slope of Rocky Mountain National Park has been subjected to at least 3 separate Pleistocene glaciations, which from oldest to youngest are correlated with the Buffalo, Bull Lake, and Pinedale glaciations of Blackwelder in the Wind River Mountains of Wyoming.

In this area, deposits of the oldest glaciation are known from only one locality. Deposits of the Bull Lake glaciation comprise 2 sets of moraines indicative of 2 advances of ice separated by a significant recession; those of the Pinedale glaciation comprise 3 sets of moraines indicative of a maximum advance of the ice and 2 recessional halts or minor readvances.

Moraines of 2 minor advances of the ice, correlated with the Temple Lake and historic stades of Neoglaciation in the Wind River Mountains, occur in the cirque heads.--Auth.

3-78. Sissons, J.B. SUBGLACIAL, MARGINAL, AND OTHER GLACIAL DRAINAGE IN THE SYRACUSE-ONEIDA AREA, NEW YORK: Geol. Soc. America, Bull., v. 71, no. 11, p. 1575-1588, fold, map, Nov. 1960, 10 refs.

In his numerous papers on central New York, H. L. Fairchild interpreted almost all the glacial-drainage features as of marginal origin. In the Syracuse-Oneida area, however, there is morphological evidence of subglacial stream erosion by both local and Great Lakes waters, of subglacial deposition by local waters, and of englacial flow in places. Evidence also indicates that the Great Lakes waters in some places flowed in channels walled by ice. Only limited evidence of ice-dammed lakes exists in the Syracuse-Oneida area itself, except at the lowest altitudes, where numerous small shore features indicate a former local lake above the highest Iroquois shoreline. There is evidence of 2 periods of Great Lakes drainage across the hillslopes of the Syracuse-Oneida area during the oscillatory retreat from the Wisconsin maximum. The writer suggests, however, that these 2 periods of Great Lakes drainage alone are insufficient to account for the vast, complex channel system.--Auth.

3-79. Holmes, Chauncey D. EVOLUTION OF TILL-STONE SHAPES, CENTRAL NEW YORK: Geol. Soc. America, Bull., v. 71, no. 11, p. 1645-1660, 2 illus., map, diag., 2 graphs, 8 tables, Nov. 1960, 8 refs.

A total of 3,234 unselected till pebbles and cobbles from 27 localities in central New York are of 3 lithologic types: sandstones, limestones, and shale (including siltstones). The most distant localities are about 20 mi. S. of the chief limestone outcrops at the Allegheny plateau escarpment. Changes in size, shape, and roundness with increasing distance of glacial transport show a relative decrease of about 25% in wedge-form and in rhombohedroid stones and a relative increase of more than 100% in ovoids. Other forms show little variation. Although wedge forms tend to be more conspicuously striated than others, the inference is that rounding predominated over faceting, and that prolonged transportation by the middle-latitude ice sheets tended to produce stones of ovoid form rather than wedge shapes as has been claimed. All 3 lithologic types show these tendencies, but in different degrees depending on relative toughness. Reduction of the larger sizes provided a continuing supply of smaller ones, and gradual depletion of the larger sizes is reflected in the changing cobble-pebble ratio downcurrent from the source outcrops. Here also, rates of change are governed largely by relative resistance. However, with increasing distance of transport, cobbles in-

crease in roundness more than pebbles, indicating less susceptibility to crushing and perhaps a faster rate of rounding. Only about 10% of the till stones attained a degree of roundness greater than 0.4 on Krumbein's scale (c on Holmes's scale).--Auth.

3-80. Myers, Arthur J. ALABASTER CAVERNS: Oklahoma Geology Notes, v. 20, no. 6, p. 132-137, 5 figs., June 1960, 3 refs.

Alabaster Cavern, which is the largest known cave in gypsum, is located in NE. Woodward County, Oklahoma. The cave has formed in the Permian Blaine formation and consists of 3 main divisions: a collapse portion, one containing domes in the roof, and a twisting tubular section. The shape of the cavern, the presence of mud as an eroding agent, and the sinkholes with surface streams draining into them indicate a vadose-water origin.--Auth.

3-81. Mirtskhulava, Ts. E. THE DEPENDENCE OF RESISTANCE TO EROSION OF COHERENT SOILS ON COHESION: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 26-28, graph, table, Jan.-Feb. 1959, pub. Apr. 1960, 8 refs.

The main factor determining resistance of soils to erosion was found to be cohesion between aggregates. Porosity, plasticity, and other factors showed no definite correlation.--F. Manheim.

3-82. Fedorov, N. V. FLUCTUATIONS IN LEVELS OF THE BLACK SEA IN POST-GLACIAL TIME: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 99-101, profile, Jan.-Feb. 1959, pub. Apr. 1960, 4 refs.

Studies of the postglacial marine terraces of the Black Sea have shed light on its history in postglacial time. It is found that fluctuations in level were synchronous with and equivalent to fluctuations in the level of the world-wide oceans. Remains of foundations from buildings and walls of ancient Greek colonies occur 1-2 m. below the present sea level and indicate a regressive phase at the time these habitations were in existence. A system of nomenclature for the transgressions and regressions of the sea is proposed.--F. Manheim.

3-83. Menard, Henry W. POSSIBLE PRE-PLEISTOCENE DEEP-SEA FANS OFF CENTRAL CALIFORNIA: Geol. Soc. America, Bull., v. 71, no. 8, p. 1271-1278, diag., 3 profiles, Aug. 1960, 22 refs.

Gigantic deep-sea fans are found at the mouths of Monterey and Delgada submarine canyons off central California. The fans merge imperceptibly and are confined within a broad trough bounded N. and S. by the Mendocino and Murray fracture zones respectively. Estimates of volumes eroded and deposited off the California coast are made in an attempt to separate trivial processes from important ones in deep-sea fan construction. Calculations indicate that material eroded from submarine canyons and the continental shelf accounts for a little more than 1/10 of the minimum volume deposited in deep-sea fans. Consequently most of the material in the Monterey and Delgada deep-sea fans must have been eroded and transported to the continental shelf by rivers and mass wasting. The canyons act as traps for

sediment transported by longshore drift and laterally along the continental shelf. This sediment is funneled down the canyons to fan areas by periodic slumping at the head of the canyon. The minimum volume of the fans were equated to the drainage area in order to determine the denudation of the Coast Ranges necessary for a Pleistocene age. The Pleistocene history of these ranges does not indicate the enormous regional denudation necessary to account for the volume of sediment in the deep-sea fans. Consequently it appears that the initial deposition of Delgada and Monterey fans was pre-Pleistocene and possibly even pre-Pliocene.

A newly discovered ridge, here named Pioneer ridge, trends W. for at least 100 mi. along lat. 38°45'N. The region S. of the ridge is 200 fathoms deeper than to the N. This ridge is similar to the parallel Mendocino ridge to the N. in all respects but size.--B. W. Pipkin.

3-84. Matthes, François E. RECONNAISSANCE OF THE GEOMORPHOLOGY AND GLACIAL GEOLOGY OF THE SAN JOAQUIN BASIN, SIERRA NEVADA, CALIFORNIA: U.S. Geol. Survey, Prof. Paer 329, 62 p., 41 illus., 4 maps (1 in pocket, scale approx. 1 in. to 2 mi.), sec., 4 profiles (1 in pocket), 1960, 41 refs.

The San Joaquin basin, in the central part of the W. slope of the Sierra Nevada, has an area of 1,760 sq. mi. In altitude it ranges from 285 ft. in the western foothills to 13,972 ft. on the crestline at the E. The basin is notable for the clarity with which its features reveal the geomorphological development and glacial history of the Sierra Nevada.

Its salient features are as follows: The San Joaquin canyon is a narrow gorge, cut into the floor of a broad, mature valley. The latter is flanked by undulating uplands, with relief attaining 1,000 ft. The uplands are surmounted by hills, mountain groups, and northwesterly-trending crests of the High Sierra. At least one crest bears tabular summits.

These features may be correlated with similar ones in the adjacent Yosemite region, and, like them, appear to be the products of 4 partial cycles of stream erosion, initiated, respectively, by Pleistocene, Pliocene, Miocene, and Eocene uplifts.

In the Pleistocene epoch, glaciers repeatedly mantled higher parts of the basin. Thus glacial features were superimposed on landscapes inherited from Pliocene and Miocene times. On the glacial map, areas covered by Wisconsin and pre-Wisconsin (El Portal) ice are distinguished (a few undifferentiated patches of ancient moraine may represent the Glacier Point stage). In the El Portal stage, the San Joaquin glacier system was the largest system of confluent glaciers in the Sierra Nevada, covering almost 1,100 sq. mi. In the Wisconsin stage, the corresponding glacier system was much less extensive.--F. M. Fryxell.

3-85. Hunter, Hugh E. TOPOGRAPHIC CONTROL BY PRIMARY IGNEOUS STRUCTURES IN THE RAGGEDY MOUNTAINS, SOUTHWESTERN OKLAHOMA: Oklahoma Geology Notes, v. 20, no. 5, p. 112-115, 5 figs., May 1960.

Basic igneous rocks crop out in the core of the Raggedy Mountains, southwestern Oklahoma. Tabular rock units a few hundred feet thick have been distinguished on the basis of mineral content and texture. Differential weathering and erosion of the tabular units has formed cuesta-like ridges and

erosional features normally associated with sedimentary strata. Analogy with sedimentary rocks is enhanced by the tendency of outcrops to develop flat surfaces parallel to pronounced planes of preferred orientation of tabular plagioclase grains. The gross topographic features of the area underlain by basic intrusive rocks are controlled primarily by the layering in the intrusive and by preferred orientation of tabular plagioclase, both of which are primary igneous structures.--Auth.

3-86. Ryabkov, N.V. THE ANCIENT DRAINAGE PATTERN IN THE KAMA BASIN AND THE MIGRATION OF ITS PRINCIPAL CHANNELS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 120-123, map, Jan.-Feb. 1959, pub. Apr. 1960.

A reconstruction of the buried drainage systems in the Kama basin has been made by means of surface geological and borehole data. The main channels, Kama and Belaya, were located on the margins of tectonic depressions, and a clear tendency for the water courses to be shifted to the right due to Coriolis force has been observed. It is considered that studies of stream migration are of importance in evaluating the stability of river banks and estimating possible water loss from future reservoirs.--F. Mannheim.

3-87. Rantsman, E. Ya. THE GEOMORPHOLOGY AND SEISMICITY OF THE VALLEY OF THE SURKHOB RIVER: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 32-35, map, profile, Jan.-Feb. 1959, pub. Apr. 1960, 5 refs.

Geomorphological studies have been carried out in the Surkhob River valley, Tadzhikistan, to complement the extensive seismic data available in this area, and to clarify the relationships between the relief, young tectonism, and seismicity.

In general, the seismicity is not associated with older geologic features, but with young movements that have given rise to poorly developed terraces on the margins of the Surkhob valley. Most of the deep dislocations have a strike parallel to the valley itself. It is noted that the displacements in depth are opposite in direction to the surface movements.--F. Mannheim.

3-88. Nichols, Robert L. GEOMORPHOLOGY OF MARGUERITE BAY AREA, PALMER PENINSULA, ANTARCTICA: Geol. Soc. America, Bull., v. 71, no. 10, p. 1421-1450, 15 illus., 17 figs. incl. maps, secs., diags., 2 tables, Oct. 1960, 71 refs.

A snow-covered plateau hundreds of miles long

extends from the northern to the southern part of the Palmer Peninsula, Antarctica. It is approximately 2,000 ft. high at the northern end and more than 6,000 ft. high at the southern end. The plateau presumably is a middle or late Tertiary peneplain which has been differentially uplifted. The peneplain was dissected after the uplift; depression of more than 1,000 ft. since then has resulted in a shoreline of submergence.

Wright, Priestley, and Gould thought that glaciation started in the Antarctic in the middle Tertiary because they interpreted breccias as tillites. The writer concludes after an examination of the literature that these breccias are probably volcanic; he believes that there is no good evidence for Tertiary Antarctic glaciation.

U-shaped valleys, cirques, horns, truncated spurs, arêtes, glacially formed bedrock basins, erratics, and moraine are common.

Evidence of deglaciation is widespread. Land ice extended more than 15 mi. beyond the present strand line during the most advanced stage of glaciation. Three thousand ft. of ice-covered areas is now deglaciated. The SW. terminus of the shelf ice in King George VI Sound retreated approximately 30 mi. from 1940 to 1949. The Northeast Glacier retreated measurably from 1940 to 1947.

A strandflat 1,500 ft. long, 400 ft. wide, and in places as much as 20 ft. above sea level was mapped. Till, buried in places by elevated beach gravels, veneers its bedrock platform. The strandflat was formed by a local glacier. Since its formation, sea level has dropped as much as 20 ft. with respect to the land. Other strandflats have had a somewhat similar history.

More than 20 elevated beaches were studied. The highest is approximately 110 ft. above sea level. Elevated beaches have also been reported from South Victoria Land and from the northern part of the Palmer Peninsula. The elevations of these beaches suggest that on the average more than 300 ft. of ice has been removed from the margin of the continent during deglaciation.

The average depth of the break in the slope of the Antarctic continental terrace is approximately 1,600 ft. The world average depth of the break in slope is approximately 430 ft. If the great depth of the Antarctic break in slope is due solely to the weight of the ice cap, the ice cap must average between 3,550 and 4,800 ft. thick.

More than 75% of the area is covered with permanent ice. Valley, piedmont, tidewater, cliff, cirque, reconstructed, outlet, transection, and fringing glaciers are common; so too are highland, snowdrift, shelf, and island ice.

The insignificant quantity of alluvium and the small size of the meltwater streams in the summer months prove that running water is of only minor importance as a geologic agent.--Auth.

3. STRUCTURAL GEOLOGY

See also: Areal and Regional Geology 3-66, 3-75; Geomorphology 3-85; Geophysics 3-158; Fuels 3-316; Engineering Geology 3-331, 3-332.

3-89. Tanner, William F. RELATIVE ACCURACIES OF THICKNESS BASED ON TRUE AND APPARENT DIPS: Shale Shaker, v. 11, no. 1, p. 17-18, diag., Sept. 1960, 2 refs.

In many relatively common situations, strati-

graphic thickness can be measured (and the section described) more satisfactorily and more accurately in the direction of a convenient apparent dip than in the direction of true dip. This is true because the most important single part of the clinometer method is the determination of the individual sights. The latter are more accurate where based on a reliable apparent dip than where based on an uncertain true dip.--Auth.

3-90. Brace, William F. AN EXTENSION OF THE GRIFFITH THEORY OF FRACTURE TO ROCKS: Jour. Geophys. Research, v. 65, no. 10, p. 3477-3480, 3 figs., Oct. 1960, 15 refs.

The Griffith theory of fracture has recently been extended by McClintock and Walsh to include the closing of Griffith cracks during compression with the development of frictional forces along crack surfaces.

This modified Griffith theory can be used to predict failure of any brittle material, such as rock, for a general stress state. The predicted failure condition is shown to be of the form $\pm r = 2K - \mu\sigma$ in the Mohr diagram (in the region of compression), where K is the tensile or $1/8$ of the compressive strength of the material and μ is the coefficient of sliding friction at crack surfaces. For a coefficient of friction of 0.8 to 1.0 this failure condition is nearly identical with the empirical Coulomb failure law observed for rocks (in the region of compression). This suggests that the Griffith mechanism of crack growth plays an important part in the fracture of rocks at low confining pressures.--Auth.

3-91. Kelley, Vincent C. SLIPS AND SEPARATIONS: Geol. Soc. America, Bull., v. 71, no. 10, p. 1545-1546, Oct. 1960, 18 refs.

Inasmuch as "left" and "right" pertain to lateral situations it is proposed that "lateral" be deleted from the compound adjectives employed in such terms as "right-lateral slip faults." Instead, the simpler and clearer expressions such as "left offset," "right wrenching," "left slip," "right separation," etc., are better. The terms "sinistral" or "dextral" may be substituted for "left" and "right," but the confusion currently taught that "sinistral" when applied refers to slip, whereas "left-lateral" refers to separation should be avoided.--Auth.

3-92. Hill, Mason L. FAULT SYMBOLS: Am. Geol. Inst., AGI Data Sheet 20, 2 p. in GeoTimes, v. 5, no. 3, p. 23-24, Oct. 1960, ref.; also pub. separately.

This data sheet reproduces, in compact reference format, a uniform set of fault symbols designed to remove the ambiguity resulting from failure of traditional symbols to distinguish between fault slip and fault separation. The 21 basic symbols are grouped under general symbols, slip symbols for maps, slip symbols for sections, and separation symbols for maps.--M. Russell.

3-93. Voinovsky-Kruger, K.G. TECTONIC JUXTAPOSITION OF FACIES: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 70-72, Jan.-Feb. 1959, pub. Apr. 1960, 3 refs.

Issue is taken with the widely accepted concept that sharply differing facies on opposite sides of a tectonic suture are indications of low-angle overthrusts with considerable displacement. It is found that the narrower the transition between sediment facies, the more easily will these strata become

displaced and thrust during folding, due to different mechanical properties of the sediments. It is therefore considered that tectonic juxtaposition of facies may often indicate small horizontal displacement and a narrow facies transition rather than long displacement.--F. Manheim.

3-94. Trusheim, F. MECHANISM OF SALT MIGRATION IN NORTHERN GERMANY: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 9, p. 1519-1540, 3 maps, 2 charts, 6 secs., 7 diag., 5 profiles, Sept. 1960, 34 refs.

The object of this paper is to describe and explain the formation of salt stock structures in northern Germany and to contribute in this way to a better understanding of similar phenomena in other parts of the world.

The majority of the structures in the North German basin can be directly or indirectly attributed to "halokinesis." This term, proposed by the writer, designates the formation of salt structures and their structural and stratigraphic implications, which are essentially the result of the autonomous movements of salt under the influence of gravity. Phase-bound tectonic forces play only a minor part.

The Permian salt structures of northern Germany are classified into salt pillows, salt stocks, salt walls, and extrusions along fissures. They are accompanied by primary, secondary, and third-order peripheral sinks. The halokinetic movements have taken place in an essentially continuous and autonomous fashion from the Triassic to the present day. Reckoned throughout long periods of geological time, the absolute rate of flow of the salt averages 0.3 mm. per year.--Auth.

3-95. Cook, Earl F. BRECCIA BLOCKS (MISSISSIPPIAN) OF THE WELCOME SPRING AREA, SOUTHWEST UTAH: Geol. Soc. America, Bull., v. 71, no. 11, p. 1709-1712, 2 maps, sec., Nov. 1960, 6 refs.

Breccia blocks of Mississippian limestone, resting on gravel and sand of probable late Pliocene or Pleistocene age, previously interpreted as remnants of a Tertiary thrust sheet, probably were not pushed but slipped from the adjacent mountain slopes, where they had been parts of a thrust sheet.--Auth.

3-96. Amstutz, G.C. GEOMETRIC CLASSIFICATION OF ROCKS AND MINERAL DEPOSITS: Am. Geol. Inst., AGI Data Sheet 21, 2 p., in GeoTimes, v. 5, no. 4, p. 23-24, 11 diag., Nov.-Dec. 1960, ref.; also pub. separately.

This set of reference diagrams illustrates a system of geometric classification of rock fabrics free of genetic connotations, encompassing and indicating gradations by spatial arrangement of 11 patterns - stromatolitic, merismitic, ophalmitic, and massive fabrics. The basic intergrowth patterns of minerals is depicted as falling into 3 main types further subdivided for a total of 9 recognizable distinctions.--M. Russell.

See also: Structural Geology 3-93; Paleontology 3-142, 3-152; Sedimentary Petrology 3-262, 3-263, 3-267; Fuels 3-314.

3-97. Harbour, R. L. **PRECAMBRIAN ROCKS AT NORTH FRANKLIN MOUNTAIN, TEXAS:** Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 11, p. 1785-1792, 3 illus., map, Nov. 1960, 8 refs.

At North Franklin Mountain in the western tip of Texas, more than 5,000 ft. of sedimentary and volcanic rocks lie unconformably beneath the Bliss sandstone (Upper Cambrian). Except for algal structures, these older rocks are nonfossiliferous and are thought to be Precambrian in age. Granite, probably Precambrian, is intruded into the sequence.

In ascending order the Precambrian rocks consist of the Castner limestone (new name), the Mundy breccia (new name), the Lanoria quartzite, and an unnamed rhyolite unit. The Castner is 1,100 ft. thick and includes limestone, hornfels, and chert, as well as diabase sills. It contains moundlike algal structures near the base and rests on intrusive granite. The Mundy, ranging from a trace to 250 ft. thick, consists of basalt rubble of unknown source resting unconformably on the Castner. The Lanoria quartzite, 2,600 ft. thick, is composed of fine-grained sandstone, and shale, all metamorphosed. It is divided into 3 members by a middle unit of massive quartzite. The rhyolite unit contains rounded pebbles of Lanoria quartzite at its base and attains its maximum known thickness, 1,400 ft. at North Franklin Mountain.

The Castner limestone may be equivalent to the Allamoore limestone of Van Horn area, 100 mi. to the E. However, other Precambrian formations in the 2 areas are so unlike that positive correlation can not be made.--Auth.

3-98. Roth, Robert I. **SWISHER GABBROIC TERRANE OF TEXAS PANHANDLE:** Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 11, p. 1775-1784, 6 illus., 2 maps, log, Nov. 1960, ref.

Two wells recently completed in the Plainview basin of the Panhandle of Texas have yielded important geologic information concerning the age of the basement complex. A core from the Humble Oil and Refining Company's Howard Ranch No. 1, Briscoe County, Texas, contained unmetamorphosed fossiliferous Paleozoic sediments intruded by diabase. This fact indicates that a part of the "Swisher gabbroic terrane" is younger than Precambrian. Another core, from the Humble Oil and Refining Company's Reinauer No. 1, Deaf Smith County, Texas, was determined by the K-Ar method to have a minimum age of 650,000,000 years, or late Precambrian. A reexamination of all the wells drilled in the "Swisher gabbroic terrane" indicated that much of the gabbro is a diabase.--Auth.

3-99. Huffman, George G. **RELATIONSHIP OF PALEOZOIC BOUNDARIES TO MARINE TRANSGRESSIONS AND OROGENIC MOVEMENTS:** Oklahoma Geology Notes, v. 20, no. 5, 116-119, fig., May 1960.

A time-transgression diagram for the Paleozoic era indicates that Paleozoic history of North America includes 4 major transgressive-regressive cycles. Marine transgressions on the craton accompany orogenic movement in the mobile belt. Intersystemic boundaries are sharply defined in orogenic areas but poorly defined on the craton within the transgressive-

regressive cycle. Marine regressions accompany subsidence in geosynclinal belts. Intersystemic boundaries are well defined on the craton following regression; unconformity decreases toward the geosyncline and essential conformity exists there.

It is believed that this concept has an important bearing on the problem of intersystemic boundaries in such units as the Late Devonian-Early Mississippian Chattanooga formation and its correlatives and the Late Mississippian-Early Pennsylvanian Goddard-Springer sequence.--Auth.

3-100. Worden, John A. **PRE-DESMOINESIAN ISOPACHOUS AND PALEOGEOLOGIC STUDIES OF THE AMARILLO-HUGOTON AREA:** Shale Shaker, v. 10, no. 9, p. 2-28, 17 maps, secs., May 1960, 27 refs.

The area of study includes approximately 38,000 sq. mi. in Oklahoma, Texas, Kansas, Colorado, and New Mexico. It lies within 2 major physiographic provinces, the Central Lowland province and the Great Plains province. The Amarillo uplift represents the general southern limit of the area of study; the Anadarko basin occupies the E.-central part of the area; the Hugoton embayment, the Northwest and the Dalhart basin and Sierra Grande uplift, the western part.

Through the use of cross sections and isopachous maps it is shown that all the pre-Pennsylvanian units thicken to the S. and E. The undulating zero isopachous line of the various formations is due to either postdepositional erosion or predepositional irregularity of the unconformity surface. The Atokan thickens also to the S. and E., being thickest to the S. immediately in front of the Amarillo uplift.

Paleogeologic maps of the pre-Mississippian surface show Viola overlaps Simpson in the N. and W., indicating a post-Simpson period of erosion. Pre-Pennsylvanian paleogeography illustrates the overlap of the Mississippian system on an erosional surface and shows a post-Mississippian unconformity surface on which Morrowan rocks were deposited.--C. E. Branham.

3-101. Jones, Cecil L., Jr. **AN ISOPACH, STRUCTURAL, AND PALEOGEOLOGIC STUDY OF PRE-DESMOINESIAN UNITS IN NORTH CENTRAL OKLAHOMA:** Shale Shaker, v. 10, no. 5, p. 2-19, 18 maps, chart, Jan. 1960, 59 refs.; discussion by John T. Bado, p. 19-20.

Pre-Des Moinesian rocks in N.-central Oklahoma are known in the subsurface throughout the thesis area. They are in normal sequence from Precambrian granite to the Atokan. Isopachous maps of separate groups in the area have indicated the following conclusions. All of the units deposited prior to the Woodford shale thin due to truncation by the pre-Woodford unconformity to the NE. The Arbuckle limestone ranges from 200 ft. in thickness in Osage County to 2,000 ft. in Canadian County. The Simpson group varies from 0 ft. in the NE. to 1,100 ft. in the SW. The Viola group varies from 0 to 500 ft. The Sylvan shale varies from 0 to 150 ft. The Hunton group is limited to the SW. half of the area.

The Woodford shale was deposited uniformly over the area and averages 50 ft. in thickness. The local areas where it is not present are due to later erosion or nondeposition in structurally high areas. The Mississippian limestone has been eroded by the pre-Des Moinesian unconformity but is present throughout and varies from 250 ft. in the NE. to 1,388 ft. in

adian County. The Springer, Morrow, and Atoka are present only in the SW. and SE. corners of the basin area.

A map of the pre-Woodford paleogeology represents one of the major unconformities in the Midcontinent region. All older beds are affected, and units are progressively truncated from NE. to SW. A map of the pre-Des Moinesian paleogeology clearly represents the pre-Pennsylvanian paleogeology well. Structure contour maps on the above units show regional dip to the SW. that shows a successive increase in rate as younger beds are mapped. The buckle ranges from 1,500 ft. in depth in the E. to 1000 ft. in Canadian County. The Mississippian is at the rate of only 40 to 45 ft. per mi. A short geologic history of the area concludes the paper.--C.E. Branham.

102. Sukhov, I.M. THE AGE OF UNFOSSILIFEROUS LOWER PALEOZOIC STRATA OF THE WESTER REGION: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 3, p. 51-54, illus., table, Jan.-Feb. 1959, pub. Apr. 1960, 13 refs.

Previous studies and stratigraphic evidence on the sediments exposed in the Dneestr valleys are summarized. The whole sequence is placed in the Tremadocian, Arenigian, Llandelian, and Caradocian stages of the Ordovician, and a revised stratigraphic nomenclature is proposed.--F. Manheim.

103. Nalivkin, D.V. THE AGE OF SALT-BEARING FORMATIONS ON THE RUSSIAN PLATFORM: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 78-79, Jan.-Feb. 1959, pub. Apr. 1960, 2 refs.

Three salt-bearing units are widespread on the Russian platform, Middle Devonian, Famennian, and Upper Permian. Two units are commonly present simultaneously in the salt-bearing districts, but 1 or 2 are infrequent. The distribution and age of the salt-bearing units is of especial importance since it is considered that they are formed under conditions favorable to the accumulation of oil and gas.--F. Manheim.

104. Andrichuk, John M. FACIES ANALYSIS OF UPPER DEVONIAN WABAMUN GROUP IN WEST-CENTRAL ALBERTA, CANADA: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 10, p. 1651-1681, 2 illus., 7 maps, 8 secs., Oct. 1960, 40 refs.

The Wabamun group, consisting mainly of carbonate rocks and anhydrite, increases in thickness westward from less than 500 ft. in the Leduc and Stettler areas to approximately 1,800 ft. in part of the Rocky Mountains of Alberta. E. of Leduc and N. of Stettler, the Wabamun has been irregularly truncated by pre-Cretaceous erosion.

For purposes of facies analysis the Wabamun is divided into 4 units: 1) basal unit including the uppermost evaporitic interval and lateral marine carbonate equivalents; 2) lower middle Wabamun representing the overlying interval to the top of the crossfield dolomite in the Calgary area; 3) upper middle Wabamun including post-Crossfield and pre-Valley beds; and 4) upper Wabamun representing the Big Valley formation and approximate lateral equivalents.

The evaporites and dolomites are dominant in the northeastern part of the map-area, limestones in the

northwestern part (and locally at the SW.), and fine to coarse crystalline dolomite in the intervening area.

Evaporites and associated extremely fine-textured dolomites exhibit most widespread distribution in the basal Wabamun. The main evaporites extend NW. through Stettler to Leduc whereas the extremely fine-textured dolomites also occur farther NW. In the middle Wabamun, the evaporites terminate a relatively short distance NW. and N. of Stettler because of probable removal by solution and pre-Cretaceous erosion. Presumably middle Wabamun evaporites originally extended N. beyond their present limit. During deposition of the basal and upper Wabamun units, a subsidiary evaporite province occurred in the foothills belt W. of Calgary and may have extended N. as far as the Clearwater River.

Limestones range from calcilutites to calcarenites and exhibit incipient dolomitization that commonly imparts a mottled appearance to the rock. The calcarenites are generally of the pseudo-oölitic or pelletoid type, although bioclastic limestone is characteristic of the uppermost, and locally, of lower beds.

The pelletoid limestones and calcilutites were deposited on a widespread bank on which slight restriction of the shallow waters promoted precipitation of calcium carbonate. Anhydrites and cryptocrystalline dolomite were precipitated in the Stettler-Drumheller area near the bank margin at the E., and the associated calcareous muds were diagenetically dolomitized to microsucrosic dolomite. Coarser (very fine to medium crystalline) dolomites are characteristic of a belt between the limestone province at the NW. and evaporites at the SE. Local vuggy dolomite sections in this belt are interpreted to be possible reefs.

Petroleum has accumulated in 2 main types of stratigraphically controlled traps within the Wabamun group. Facies change from porous secondary dolomites to relatively nonpermeable equivalents approximately up regional dip (mainly eastward) is responsible for gas entrapment in the Okotoks-East Calgary-Olds trend of fields. In the Edmonton area, oil and gas has been localized in erosional hills made up of porous Wabamun dolomites at the pre-Cretaceous unconformity.--Auth.

3-105. Clark, David L., and Joseph H. Becker. UPPER DEVONIAN CORRELATIONS IN WESTERN UTAH AND EASTERN NEVADA: Geol. Soc. America, Bull., v. 71, no. 11, p. 1661-1674, 2 pls., illus., map, chart, sec., table, Nov. 1960, 34 refs.

From the Devils Gate limestone, Pilot shale, and Pinyon Peak limestone of the eastern Great Basin, the writers have obtained 54 species of 28 conodont genera. Species of the genus *Palmatolepis* can be used in refined Devonian correlation and classification with the standard stages based on ammonoid genera in Europe. Three distinct assemblage zones, designated A, B, and C, are classified as upper *Manticoceras*, uppermost *Manticoceras* or lower *Cheiloceras* and upper *Cheiloceras* or lower *Platyclymenia*, respectively.

The upper part of the Devils Gate can be correlated with the lower and middle Pilot and the upper Pinyon Peak. Zone A, present in these formations, can be correlated with zone II of the Houy formation in Texas, the Independence shale and its equivalents in Iowa and Illinois, the Olentangy shale of Ohio, and the lower part of the Perrysburg formation and its equivalents in western New York and northern Penn-

sylvania.

Zones B and C, present in the middle-lower and middle part of the Pilot and upper part of the Devils Gate and Pinyon Peak, can be correlated with zone III of the Texas Houy formation, the Grassy Creek shale and its equivalents in Illinois and Iowa, and other sections in the midcontinent and eastern United States including the Huron member of the Ohio shale of Ohio and Kentucky and the middle and upper part of the Perrysburg formation in New York and Pennsylvania.--Auth.

3-106. Krylova, A.K. ON THE UPPER DEVONIAN OF STOLB ISLAND IN THE LENA ESTUARY: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 23-25, Jan.-Feb. 1959, pub. Apr. 1960, 6 refs.

Upper Devonian limestones from Stolb island are described. Fauna in the limestones include goniatites, spiriferid and lingulid brachiopods, and crinoids. The particular importance of these outcrops is that the upper levels consist of bituminous limestones which may be correlated faunally with the Domanik oil source beds of the arctic regions, Timan, and the eastern Russian platform. The oil prospects of this horizon may therefore be extended to the northeastern Siberian platform.--F. Manheim.

3-107. Baltz, Elmer H., and Charles B. Read. ROCKS OF MISSISSIPPIAN AND PROBABLE DEVONIAN AGE IN SANGRE DE CRISTO MOUNTAINS, NEW MEXICO: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 11, p. 1749-1774, 4 illus., 2 maps, 2 charts, 4 secs., Nov. 1960, 35 refs.

In the Sangre de Cristo Mountains of northern New Mexico, Precambrian rocks are overlain by a thin but complex sequence of sandstone and limestone of pre-Pennsylvanian age. These rocks, formerly classed variously as the lower limestone member of the Sandia formation, and the Arroyo Peñasco formation, are here divided into 2 new formations on lithologic bases.

The lower formation, consisting of sandstone, sandy dolomitic limestone, and crystalline and clastic limestone, is here named the Espiritu Santo formation. The Espiritu Santo formation ranges in thickness from a trace to more than 80 ft., with an irregular but general increase in thickness from S. to N. No fossils of undoubted stratigraphic significance have been found in this formation. On the basis of stratigraphic position and lithologic similarity to rocks of Devonian age in Colorado, the Espiritu Santo formation is classified as Devonian(?).

Overlying the Espiritu Santo formation, with widespread erosional unconformity, is a sequence of limestone breccia and conglomerate, crystalline limestone, and calcarenite here named the Tererro formation. The Tererro formation has been divided into 3 members. In ascending order these are the Macho, Manuelitas, and Cowles members. The Macho member is composed of limestone breccia derived in large part from solution and collapse of cavernous parts of the upper part of the Espiritu Santo formation, and in minor part from collapsed parts of the overlying Manuelitas member. The Manuelitas member rests unconformably on the Macho member and is composed of crystalline limestone, limestone pebble and cobble conglomerate, and calcarenite. At many places these beds were involved in collapse into large sinkholes in the Macho member and Espiritu Santo formation

during deposition of the Manuelitas member. The Cowles member rests unconformably on the Manuelitas member and is composed of a lower unit of calcarenite and an upper unit, present locally, of marly quartz siltstone and intercalated limestone beds. The Tererro formation ranges in thickness from a trace to 130 ft. in the southern part of the Sangre de Cristo Mountains and from 6 to 48 ft. thick farther N. A sparse faunule found in the Manuelitas member indicates Early Mississippian age for that part of the Tererro formation.

The Tererro formation is overlain with erosional unconformity by sandstone and coaly shale beds of the Sandia formation, as here restricted, of Early Pennsylvanian age.--Auth.

3-108. Tomlinson, C.W., and Allan P. Bennison. TIFF MEMBER OF GODDARD FORMATION: Oklahoma Geology Notes, v. 20, no. 5, p. 123-124, May, 1960, 2 refs.

This member [Mississippian] was first described by M.K. Elias and subsequently named Grindstone Creek member by Tomlinson. Because the name was preoccupied it was changed to Tiff member. The member differs from other units of the Goddard in its lithologic character, being a 10- to 40-ft.-thick lentil of light to dark gray pelletal or gritty claystone. The pellets range from 0.2 to 2.0 mm. in diameter and consist of partly glauconitized or pyritized phosphatic claystone. The member contains floral remains, ammonoids, and several conodont zones.--A. Nicholson.

3-109. Teodorovich, G.I., and others. THE SUBDIVISION OF THE LOWER VISEAN AND THE BEDS ALONG THE BOUNDARY OF THE VISEAN-TOURNAISIAN OF THE MOUNTAINS OF BASHKIRIA ACCORDING TO THE FORAMINIFERAL FAUNA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 92-95, Jan.-Feb. 1959, pub. Apr. 1960, 7 refs.

Investigation has been made of the problem of the boundary of the Tournaisian and Visean [Mississippian] on the W. flank of the S. Urals. The section has a transitional character and the number of Foraminifera are relatively scanty. Regional correlation and stratigraphic relationships to other areas is discussed and a list of the Foraminifera and other fauna found in the sections is given.--F. Manheim.

3-110. Falls, Thomas G. PERMIAN STRATIGRAPHY AT CARLIN CANYON, NEVADA: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 10, p. 1692-1703, map, Oct. 1960, 9 refs.

Three new formation names are defined for a hitherto undescribed section of Permian marine sedimentary rocks exposed N. of Carlin Canyon, Elko County, northeastern Nevada.

The name of Buckskin Mountain formation is proposed for a 1,200-ft. uniform sequence of yellow-tan quartzose calcisiltites and minor gray calcarenite beds of Wolfcampian age conformably overlying the Pennsylvanian-Permian Strathearn formation and conformably overlain by the Permian Beacon Flat formation.

The name of Beacon Flat formation is proposed for a 3-member unit 2,800 ft. thick. The 550-ft. lower member of gray, silty calcarenites and chert beds contains the Wolfcampian-Leonardian boundary. Alluvium covers the undescribed middle member.

erty, fossiliferous, gray calcarenites make up the 150-ft. upper member, conformably overlain by the Permian Carlin Canyon formation.

The name of Carlin Canyon formation is proposed for a 1,225-ft. sequence of tan quartzose calcisiltites and massive brown cherts of Leonardian and possibly Guadalupian age, unconformably overlain by the Miocene-Pliocene Humboldt formation.

The Buckskin Mountain formation is probably correlative with parts of the Carbon Ridge and Arcutus formations. Carlin Canyon formation sediments reflect orogeny and volcanism taking place in western Nevada, as well as local uplift, during Leonardian and possibly Guadalupian time.--Auth.

3-111. Tikhvinsky, I.N. THE AGE OF THE SOLIKAMSK SERIES: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 96-98, 2 secs., Jan.-Feb. 1959, pub. Apr. 1960, 11 refs.

Extensive core material from borings in the eastern part of Tataria, U.S.S.R., has led the author to conclude that the Solikamsk series is of Upper Permian age and that it rests unconformably on the eroded surface of the Kungurian evaporites. It is also believed that the Solikamsk series intertongues with the overlying Ufa beds and that these 2 units should be considered as a single stage.--F. Manheim.

3-112. Amantov, V.A., and G.P. Radchenko. ON THE CONTINENTAL PERMO-TRIASSIC DEPOSITS OF CENTRAL MONGOLIA (KHANGAI HIGHLANDS): Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 20-22, Jan.-Feb. 1959, pub. Apr. 1960,

In the course of recent geological investigations of the Khangai highlands orogenic region it has been possible to date a continental series of coarse clastics and sandy clays by means of plant remains and a very abundant spore assemblage. The chief features of the sediments are their monotonous gray color, deltaic cross-bedding, and typical shallow-water continental features such as ripple marks, clay concretions, and plant remains. Spores and pollen, as well as a cordaitid flora, suggest a Late Permian age, while other floral forms found in the association have to date only been identified from Triassic deposits.--F. Manheim.

3-113. Bukiya, S.G. NEW DATA ON THE AGE OF THE DESSKII FORMATION: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 55-57, Jan.-Feb. 1959, pub. Apr. 1960, 5 refs.

Stratigraphic and paleontological studies on the Desskii [Desian] formation are reported and previous nomenclature summarized. On the basis of spores and pollen, as well as faunal data, it is concluded that the age of the formation is Triassic and that previous designations in published geological maps and stratigraphic compilations as Devonian and Carboniferous are incorrect.--F. Manheim.

3-114. Romer, Alfred S. VERTEBRATE-BEARING CONTINENTAL TRIASSIC STRATA IN MENDOZA REGION, ARGENTINA: Geol. Soc. America, Bull., v. 71, no. 9, p. 1279-1293, 2 maps, table, Sept. 1960, 80 refs.

Rusconi and others have described numerous fishes and amphibians from continental Triassic sediments in the Mendoza region of Argentina, but their stratigraphic position has been poorly understood because of conflicting stratigraphic terminology and incomplete published data on the region. All vertebrate remains appear to be derived from a sedimentary cycle termed the Cacheuta series by a majority of workers. The age appears to be middle Triassic.--Auth.

3-115. Cecioni, Giovanni O., and Floreal García Araya. STRATIGRAPHY OF COASTAL RANGE IN TARAPACÁ PROVINCE, CHILE: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 10, p. 1609-1620, map, chart, Oct. 1960, 19 refs.

The stratigraphy of the Jurassic sediments of the coastal range in Tarapacá Province is examined although the geology of this area is relatively unknown. Strata range in age from Bajocian to Oxfordian, but no ammonites of definite Bathonian age have been found.

The continental Atajaña formation of Neocomian age overlaps at about the same topographic level several Jurassic formations which are quite different in age and lithologic character. The Atajaña formation grades upward into the marine sandy Blanco formation which contains Berriasian ammonites.

The Jurassic sediments are folded into a general northerly trend, whereas the Cretaceous sediments have a general easterly strike. Between the upper Oxfordian and the basal Cretaceous there is evidence of a major orogeny, which by definition is Nevadian. The Nevadian folding in northern Chile, as in Canada and Alaska, has been gentler than in western United States.

The Andean diorite was locally intruded after the Nevadian orogeny and was subsequently eroded, supplying the pebbles of the Cretaceous basal conglomerates. A working hypothesis of a gradually younger age of the Andean diorite toward the S. of the Chilean Andes is proposed.--Auth.

3-116. Konivets, V.I. FACIES COMPOSITION OF THE COAL-BEARING STRATA OF THE ALDAN-OLEKHMA WATERSHED: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 61-64, Jan.-Feb. 1959, pub. Apr. 1960, 6 refs.

The lithology of the coal-bearing deposits of a part of the south Yakutiya coal basin has been studied in bed-by-bed detail and the relation of the lithology to the depositional origin of the deposits considered. The coal-bearing strata are regarded as middle Upper Jurassic in age and consist of siltstones, argillites, carbonaceous argillites, and coal beds. The sequence is considered largely as a continental swamp facies which was deposited in a zone of broad regional downwarps.--F. Manheim.

3-117. Popenoe, W.P., and others. CORRELATION OF THE CRETACEOUS FORMATIONS OF THE PACIFIC COAST (UNITED STATES AND NORTH-WESTERN MEXICO): Geol. Soc. America, Bull., v. 71, no. 10, p. 1491-1540, 5 maps, fold. chart, Oct. 1960, approx. 180 refs.

This paper includes a discussion of the historical development of stratigraphic classification of Cretaceous rocks on the Pacific Coast of the United States, a summary of the faunal evidence for correlating the

Cretaceous rocks with the European stages, and all the stratigraphic and faunal data available for 61 areas along the Pacific Coast in Washington, Oregon, California, and NW. Mexico. Many of these data, particularly for Washington and Oregon, have not been published previously. The chart includes lists of fossils that are most useful stratigraphically and presents correlations with British Columbia, Japan, and the western interior of the United States. Included are maps that show the general distribution of Cretaceous rocks along the Pacific Coast. Such maps for Oregon and Washington show occurrences that are not shown on any other published maps.--Auth.

3-118. Garetsky, R.G., and others. THE STRATIGRAPHY OF THE UPPER CRETACEOUS DEPOSITS OF THE KASSARMA ANTICLINE ON THE WEST COAST OF THE ARAL SEA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 80-83, sec., Jan.-Feb. 1959, pub. Apr. 1960, 11 refs.

Cretaceous deposits crop out continuously in the cliffs of the W. coast of the Aral sea for more than 25 km. Paleontologic examination of these sediments indicates the presence of characteristic Senomanian, Turonian, and lower Campanian fauna. A further possibility is the appearance of upper Maestrichtian beds in the lowest exposed horizons.--F. Manheim.

3-119. Morozova, V.G. THE STRATIGRAPHY OF THE DANIAN-MONTIAN DEPOSITS OF THE CRIMEA ACCORDING TO FORAMINIFERA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 84-88, illus., table, Jan.-Feb. 1959, pub. Apr. 1960, 11 refs.

The Danian stage is widely distributed in the U.S.S.R. and is particularly well developed in the Crimean mountains. In the Tarkhankut peninsula of the Crimea the Danian-Montian deposits [Cretaceous-Tertiary] reach a maximum thickness of more than 300 m., consisting of uniform carbonates, marls, marly limestones, and intercalated clays.

Foraminiferal investigations in this region have made possible the defining of a boundary between the Danian and Montian, and the subdivision of the sequence into 3 independent stratigraphic units. Morphological description of 4 new foraminiferal subspecies and species is presented.--F. Manheim.

3-120. Mchedlishvili, P.A. THE AGE OF THE COAL-BEARING SEDIMENTS OF THE DILIZHAN REGION OF ARMENIA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 46-47, Jan.-Feb. 1959, pub. Apr. 1960, 8 refs.

The flora of the coal-bearing Dilizhan sediments consist mainly of tropical and subtropical evergreens that reflect a hot and dry climate. Comparative data from France, Germany, Georgia, and Azerbaijan, as well as climatic considerations indicate that this flora is of middle Oligocene age. It is also concluded that the Dilizhan coal deposits are of approximately the same age as those in the Akhaltsikhe region of Georgia.--F. Manheim.

3-121. Aleksin, A.A., and R.L. Merklin. MIDDLE MIOCENE OYSTER BEDS IN THE BUTTES OF SOUTHEASTERN USTYURT: Akad. Nauk SSSR,

Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 36-38, Jan.-Feb. 1959, pub. Apr. 1960, 10 refs.

Molluscs from Neogene sediments in the region E. of the Caspian Sea have been studied and the sediments correlated regionally. It is suggested that 2 of the prominent biofacies, *Crassostrea* and *Oncofophora*, are synchronous and were widely distributed along the northern shore of the Helvetian para-Tethys sea. Optimum conditions for oyster bank development are postulated to have been contributed by a large river discharge in the area, delivering terrestrial detritus and enriching nearshore waters in calcium carbonate.--F. Manheim.

3-122. Varlamov, I.P. THE KINEL'SKI DEPOSITS IN THE NUGUSH VALLEY (RIGHT HAND TRIBUTARY OF THE BELAYA RIVER): Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 58-60, Jan.-Feb. 1959, pub. Apr. 1960, 4 refs.

The lithology and paleontology of the Kinelskian deposits of the Nugush valley (southern Urals, U.S.S.R.) are discussed. On the basis of palynological investigations by Morevaya and Gaigerova and regional stratigraphic considerations these sediments are regarded as being of upper Miocene to middle Pliocene age.--F. Manheim.

3-123. Stephens, John J. STRATIGRAPHY AND PALEONTOLOGY OF A LATE PLEISTOCENE BASIN, HARPER COUNTY, OKLAHOMA: Geol. Soc. America, Bull., v. 71, no. 11, p. 1675-1702, 4 illus., 4 maps (1 fold.), sec., 6 diag., Nov. 1960, 41 refs.

Pleistocene (Illinoian) lake deposits are exposed in the Doby Springs area, Harper County, Oklahoma. The collapse basin in which these beds were deposited resulted from solution of salt or anhydrite in the underlying Permian strata. The rim of the basin is made up of the Permian Whitehorse group, the Pliocene Ogallala formation, and the Pleistocene (Kansan to Yarmouth) Crooked Creek formation.

In Kansan time a southeastward-flowing stream cut through the Ogallala formation into the Permian strata. This stream deposited the gravels, sands, and silts of the Crooked Creek formation in its valley. During Yarmouth time a caliche formed in the top of the formation. In Illinoian time a collapse basin formed in the Doby Springs area. Lake sediments containing the Doby Springs local fauna were deposited in this basin. Settling and collapse along the southern edge imparted the present dip to the lake beds. In Sangamon time the area was drained, and a caliche formed in the upper part of the lake sediments; later, further collapse occurred to the N. and imparted the northward dip to the northern part of the initial basin deposits. The present outward radial drainage results from the collapse on the margins of the initial basin. The alluvial deposits along the modern streams are of Wisconsin and Recent age.

The Doby Springs local fauna contained in the Illinoian lake deposits consists of the remains of ostracods, mollusks, fishes, amphibians, reptiles, birds, and mammals. The 7 fishes (white sucker, creek chub, flathead chub, fathead minnow, black bullhead, green sunfish, and yellow perch) indicate a cool, upstream, lake environment with smaller streams running into the lake.

Twenty-four forms of mammals from the Doby Springs local fauna are discussed, and a new species of the mammalian genus, *Peromyscus*, is described.

The following extant small mammals indicate a marsh environment with surrounding lowland meadows and some trees: arctic shrew, masked shrew, northern water shrew, shorttail shrew, muskrat, meadow vole, and jumping mouse.

The climate in the area is determined by plotting the present-day distribution of the living forms and arriving at an area of overlap. This area of overlap for the species recorded in the Doby Springs local fauna lies in southeastern North Dakota and northeastern South Dakota. The climate in Oklahoma during Illinoian time was probably similar to that in the area of overlap today. Lower summer temperatures and more effective moisture are indicated.

The Doby Springs local fauna is correlated with the Berends local fauna, Beaver County, Oklahoma, and the Butler Spring local fauna, Meade County, Kansas.--Auth.

3-124. Eardley, A. J., and Vasyi Gvosdetsky. ANALYSIS OF PLEISTOCENE CORE FROM GREAT SALT LAKE, UTAH: Geol. Soc. America, Bull., v. 71, no. 9, p. 1323-1344, 2 logs (1 fold), chart, 4 tables, Sept. 1960, 21 refs.

A continuous core was taken to a depth of 650 ft. on the shore of Great Salt Lake, 1 mi. NNE. of the Saltair resort, about halfway between the Oquirrh Mountains and Antelope Island, Utah. Its contents and properties were examined and analyzed for the Pleistocene record of lakes and climatic changes. Of significance in the interpretation were Ca and Mg carbonates, clay minerals, sand fractions, volcanic ashes, soils, radioactivity, laminations, oolites and fecal pellets, ostracodes, mollusks, and C^{14} dates. By integrating the several climatic indicators and other data the following conclusions were reached.

1) The core probably penetrated sediments deposited during the Wisconsin, Sangamon, Illinoian, Yarmouth, Kansan, and part of the Aftonian ages of the Pleistocene. The several times of soil formation represent hiatuses in the sedimentary record, but they were probably short.

2) The Pleistocene is calculated from the Saltair core to be about 800,000 years long, whereas the deep-sea cores, according to Emiliani, indicate a length of 300,000 years. The rhythms of solar radiation, according to Milankovitch and Zeuner, indicate a length of 600,000 years. The Saltair core age seems as substantial as any, yet it is very tenuous and is posted simply for future consideration.

3) No relation of the pluvial stages of the core to the Lake Bonneville beaches could be established.

4) Little firm evidence correlates the pluvial stages of the core with Rocky Mountain glacial stages.

5) The Pearlette tuff at 548 ft. is a significant time marker and according to the succession of lakes recognized in the core is early Kansan.

6) Five strong pluvial cycles are recognized, and these correlate well with the lower Mississippi Valley chronology.--Auth.

3-125. Wetherill, G. W., and others. AGE MEASUREMENTS ON MINERALS FROM THE CUTLER BATHOLITH, CUTLER, ONTARIO: Jour. Geophys. Research, v. 65, no. 8, p. 2461-2466, 2 maps, 4 tables, Aug. 1960, 9 refs.

Mineral ages have been measured by the K-A, Rb-Sr, U-Pb, and Th-Pb methods on samples of

granite and pegmatite from the Cutler batholith, Ontario. The pegmatites crosscut the granite and thus are clearly younger than the granite. However, Rb-Sr ages of both pegmatitic muscovite and feldspar agree at about 1,750 million years (m. y.), whereas Rb-Sr and K-A ages of the granitic biotites agree at about 1,300 m. y. Most other ages are intermediate. These apparent discrepancies are interpreted as the result of a hypothetical event that took place 1,300 m. y. ago, 400 m. y. after the original crystallization of the batholith. No clear petrographic evidence is found for such an event. These data show that consistent results by a single method on different minerals, or by several methods on a single mineral species, do not necessarily indicate the time of original crystallization of a granitic body.

In spite of these complexities, these data show that the Cutler granite was formed prior to the time of the Grenville metamorphism and igneous intrusion and should not be considered to be of very late Precambrian age.--Auth.

3-126. Moor, G. G. AGE RELATIONSHIPS BETWEEN BASALTS AND THE ALKALIC ULTRABASIC COMPLEX OF THE NORTHERN PART OF THE SIBERIAN PLATFORM: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 43-45, Jan.-Feb. 1959, pub. Apr. 1960, 4 refs.

Ages of basalts and alkaline-ultrabasic rocks in the northern part of the Siberian platform have been determined by the K/A method. The age of the basalts ranges from 153 to 178 million years, corresponding to a late Permian-Triassic age and agreeing with the geologic evidence. The age of the alkaline-ultrabasic complex, however, averaged 250 million years, corresponding to early or middle Carboniferous. This age is much greater than the maximum of 175 million years expected from geological data. It is felt that age determinations by other methods are necessary to resolve the conflicting evidence.--F. Manheim.

3-127. Krylov, A. Ya., and others. AGE OF GRANITOID ROCKS IN THE NORTHERN ZONE OF TIEN SHAN: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 67-69, table, Jan.-Feb. 1959, pub. Apr. 1960, 5 refs.

K/Ar age determinations have been carried out on rocks from Tien Shan. In spite of criticism of the use of rocks rather than minerals in this type of determination, consistent results have been obtained in the present case from hundreds of determinations. Age values clearly distinguish Proterozoic, Caledonian, and Hercynian cycles of intrusion at 500, 340, and 260 million years respectively. The use of the newer K decay constant of 5.57×10^{-11} year⁻¹ would increase these ages by 8 to 9%.--F. Manheim.

3-128. Knechtel, Maxwell M. STRATIGRAPHY OF THE LITTLE ROCKY MOUNTAINS AND ENCIRCLING FOOTHILLS, MONTANA: U.S. Geol. Survey, Bull. 1072-N, p. 723-752, 3 maps (col. geol. map in pocket, scale 1:48,000), logs (in pocket), 1959, 45 refs.

Rocks exposed in the Little Rocky Mountains and encircling foothills range in age from Precambrian to Quaternary and are of sedimentary, igneous, and metamorphic types. The bedrock formations range in age from pre-Belt (Precambrian) to Tertiary; the surficial materials, which include alluvium, glacial debris, and soil, were deposited in later Tertiary(?) and Quaternary time.--Auth.

5. PALEONTOLOGY

See also: Stratigraphy 3-105, 3-109, 3-114, 3-119 through 3-123; Sedimentary Petrology 3-261.

3-129. Zimmerman, Paul A., ed. **DARWIN, EVOLUTION, AND CREATION: 231 p.**, St. Louis, Missouri, Concordia Publishing House, 1959, approx. 200 refs.

The argument from religion against the Darwinian concepts of evolution, the origin and age of the earth and the life upon it is presented. Scientific and theologic reasoning are combined to argue that the Bible and science are not incompatible but that the principal conclusions of Darwin are not demonstrable and defensible. The book is organized into an introduction (by the editor) and 6 chapters: "Darwinism, Science, and the Bible," by Wilbert H. Rusch, p. 4-35; "In the Beginning God Created," by Raymond F. Surburg, p. 36-80; "The Evidence for Creation," by Paul A. Zimmerman, p. 82-102; "The Case for Evolution," by John W. Klotz, p. 104-141; "The Age of the Earth," by Paul A. Zimmerman, p. 142-166; and "The Influence of Darwinism," by Raymond F. Surburg, p. 168-204.--M. Russell.

3-130. Kabanov, K. A. **INDICATIONS OF FRESHENING OF THE HAUTERIVIAN SEA IN THE UL'YANOVSK-VOLGA DISTRICT: Akad. Nauk SSSR, Doklady, Earth Sci. Secs.**, in English translation, v. 124, no. 1-6, p. 73-75, Jan.-Feb. 1959, pub. Apr. 1960, 6 refs.

Morphological studies of ammonites, gastropods, and other fauna occurring in Lower Cretaceous (Hauterivian) rocks show that reduction in number of species and a tendency for shell dwarfing takes place on proceeding from older to younger strata. These indications, as well as paleogeographic considerations are held to confirm that freshening occurred in the Hauterivian sea.--F. Manheim.

3-131. Vologdin, A. G. **TERSIIDS OF THE CAMBRIAN DEPOSITS OF THE CHITINSK DISTRICT: Akad. Nauk SSSR, Doklady, Earth Sci. Secs.**, in English translation, v. 124, no. 1-6, p. 158-161, 2 illus., Jan.-Feb. 1959, pub. Apr. 1960, 3 refs.

Cambrian rocks from Zola, Transbaikalia, U.S.S.R. are the hosts for excellently preserved archeocyathids, which have provided much data on the internal organization of these forms. Further studies of the collection of Mikhno have clarified the morphology of the tertiids. It is concluded that these are not "protuberances" on archeocyathids, as regarded by several investigators, but independent organisms.--F. Manheim.

3-132. Zhuravleva, I. T. **ARCHAEOCYATHA OF THE BAZAIKH HORIZON OF THE KIYA RIVER: Akad. Nauk SSSR, Doklady, Earth Sci. Secs.**, in English translation, v. 124, no. 1-6, p. 148-153, illus., diag., Jan.-Feb. 1959, pub. Apr. 1960, 13 refs.

Archeocyatha of the Bazaiikh horizon [Cambrian] of the Kiya River, U.S.S.R., are described in detail. Twenty-eight genera were found, of which one is new. The most numerous genera are *Ajacyathus* Bedford, *Nochorocyathus* Zhur., and *Coscinocyathus* Born.--F. Manheim.

3-133. Strimple, Harrell L. **REGRESSIVE EVOLUTION AMONG ERISOCRINIDS: Oklahoma Geology Notes**, v. 20, no. 6, p. 151-155, 2 figs.,

June 1960, 6 refs.

Normal development in the shape of calyces of crinoids is from high conical forms to low bowl-like shapes. Some forms evolved in the opposite way, from low bowl-like forms to broad, flat bases and, in one case, to a final stage of high conical base.--C. C. Branson.

3-134. Amsden, Thomas W. **LISSATRYPOIDEA CONCENTRICA (HALL), EMEND BOUCOT AND AMSDEN: ILLUSTRATIONS OF THE LECTOTYPE: Oklahoma Geology Notes**, v. 20, no. 6, p. 138-139, fig., June 1960, 5 refs.

The lectotype of *Nucleospira concentrica* Hall 1859 from the Brownsport formation (Silurian) of western Tennessee is reillustrated. This species was later made the genotype of *Lissatrypoidea* Boucot and Amsden 1958.--Auth.

3-135. Muir-Wood, Helen, and G. Arthur Cooper. **MORPHOLOGY, CLASSIFICATION AND LIFE HABITS OF THE PRODUCTOIDEA (BRACHIOPODA): Geol. Soc. America, Mem. 81, 447 p.**, 135 pls., chart, 7 figs., 1960, approx. 500 refs.

This book is a comprehensive revision of the sub-order Productoidea, a large group of upper Paleozoic brachiopods characterized by open tubular spines. All the genera described in the extensive world literature are included, and the original descriptions are supplemented, whenever possible, by additional information obtained from examination of specimens in collections available to the authors.

The stratigraphic range and geographic distribution of the Productoidea are reviewed. They range from Lower Devonian (Onondaga) to Upper Permian, a span of about 125 million years.

In an extensive discussion of the external and internal morphology of the productoids new information concerning the shell interior and new interpretations of other anatomical features are presented.

The terminology applied to the Productoidea is listed alphabetically. Descriptions and illustrations are given of each term employed.

Life habits of the productoids are described in detail. Spines are thought to have played an important role and to have served either to anchor or attach the shell, or to steady it and keep it from being buried.

The origin of the Productoidea is still problematical. It is shown, however, that they could not have been derived from the chonetoids or from the stropheodontoids; an early strophomenoid *Leptaeniscia* with similar life habits and internal structure may have been an ancestral form.

The history of productoid classification is traced from the early attempts by de Koninck and de Verneuil, which are based wholly on exterior form and ornament, to the later classifications in which interior characters and life habits play a role. The classification proposed here makes use of exterior characters and internal details, but all features of the productoid shell are considered. Emphasis is placed on the cardinal process in defining families, and 9 types of process are described.

Two major lines of descent are traced, and the 2 groups of genera are separated into the superfamilies Strophalosioacea n. superfam. and Productacea. The Strophalosioacea are cemented throughout life by beak or clasping spines and have interareas which may be present in both valves or in the pedicle

valve only, or rarely are absent; the pedicle valve is conical, and the brachial valve opercular in some families, and the cardinal process is usually prominent, bilobed or trilobed. The Productacea are seldom cemented except in the youngest stages and when adult usually live loose on the sea bottom. They are generally attached by ringlike spines in early growth stages. Interareas, teeth, and sockets are only weakly developed in primitive forms, and the cardinal process in bilobate, trilobate, or quadrilobate.

New families of the Strophalosiacea are: Aulostegidae, Sinuatellidae, Spyridiophoridae, Teguliferinidae, and Tschernyschewiidae. New families of the Productacea are: Buxtoniidae, Gigantoproductidae, Institinidae, Leioproductidae, Overtoniidae. Twenty-nine subfamilies are also proposed.

It is only natural that careful restudy of the Productoidea would reveal many new genera, especially when the collections studied are so rich in specimens showing internal characters as those of the U.S. National Museum. A total of 167 valid genera are described and illustrated. In addition 5 doubtful names, 3 without description, are considered. Of the 167 genera 66 are new.

New genera of the Strophalosiacea are: *Chonosteges*, *Coscinarina*, *Costellaria*, *Craspedalosia*, *Crossalosia*, *Dasyalosia*, *Devonalosia*, *Echinosteges*, *Edriosteges*, *Lialosia*, *Rhamnaria*, *Sphenalosia*, *Sphenosteges*, *Xenosteges*. The new genera of Productacea are: *Acanthatia*, *Acanthoplecta*, *Alifera*, *Auloprotonia*, *Bathymyonia*, *Calliprotonia*, *Cinctifera*, *Costiferina*, *Costispinifera*, *Echinaria*, *Echinauris*, *Ericiatia*, *Fimbriaria*, *Flexaria*, *Fluctuaria*, *Galeatella*, *Geniculifera*, *Globiella*, *Grandaurispina*, *Hystriulina*, *Inflatia*, *Institifera*, *Institina*, *Laminatia*, *Levitusia*, *Marginatia*, *Megousia*, *Monticulifera*, *Orbinaria*, *Ovatia*, *Paucispinifera*, *Peniculauris*, *Pulchratia*, *Quadratia*, *Retaria*, *Reticulatia*, *Rhytiophora*, *Rudinia*, *Rugatia*, *Rugauris*, *Rugicostella*, *Rugivestis*, *Semicostella*, *Sentosia*, *Septarinia*, *Squamaria*, *Stegacanthia*, *Stipulina*, *Titanaria*, *Tubaria*, *Tylopecta*, *Undaria*.

An extensive bibliography of literature pertaining to the productoids completes the book. Nearly all the genera are illustrated by specimens including interiors, but a few are known only from the original illustrations which are reproduced.--Auth.

3-136. Jones, David L., and George Gryc. UPPER CRETACEOUS PELECYPODS OF THE GENUS *INOCERAMUS* FROM NORTHERN ALASKA: U.S. Geol. Survey, Prof. Paper 334-E, p. 149-165, 9 pls., 4 figs. incl. map, 2 tables, 1960, 38 refs.

Upper Cretaceous rocks in the Colville River region of northern Alaska contain a fauna consisting of 5 species of *Inoceramus*, all of which are known from other localities, either in the United States, Canada, Europe, or elsewhere. Associated fossils include a small number of pelecypod species, a few species of gastropods, and several species of ammonites. The species of *Inoceramus* range in age from Cenomanian to late Santonian or early Campanian, but none are of Coniacian age.

Upper Cretaceous rocks in the Colville River region are divided into 3 formations, which are, in ascending order, the Ninuluk, the Seabee, and the Schrader Bluff. *Inoceramus* (*Inoceramus*) *dunveganensis* McLearn, of Cenomanian age, is abundant in the Ninuluk formation. *Inoceramus* (*Mytiloides*) *labiatus* (Schlotheim) and *I. aff. I. (Inoceramus) cuvieri* Sowerby occur in the lower part of the Sea-

bee formation of early Turonian age. *Inoceramus* aff. *I. (I.) cuvieri* occurs alone in the upper part of the Seabee, which probably is of middle to late Turonian age. There is no evidence that this species extends into the Coniacian in northern Alaska. The Barrow Trail member of the Schrader Bluff formation contains *Inoceramus* (*Sphenoceramus*) *patootensis* de Loriol and *I. (S.) steenstrupi* de Loriol, both of late Santonian to early Campanian age. The precise age of the lower and upper members of the Schrader Bluff formation is not certain.--Auth.

3-137. Sidorova, N.P. ON THE PHYLOGENETIC RELATIONSHIPS OF THE SARMATIAN MACRIDS OF MANGYSHLAK AND USTYURT: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 154-157, chart, Jan.-Feb. 1959, pub. Apr. 1960, 12 refs.

The macrids of the eastern part of the Sarmatian [Miocene] at Mangyshlak and Ustyurt have been analyzed from a genetic point of view. A phylogenetic scheme differing from that of Kolesnikov is presented.--F. Manheim.

3-138. Yochelson, Ellis L. PERMIAN GASTROPODA OF THE SOUTHWESTERN UNITED STATES. 3. BELLEROPHONTACEA AND PATELLACEA. With Notes on Pennsylvanian Bellerophontacea: Am. Mus. Nat. History, Bull., v. 119, art. 4, p. 209-293, 12 pls., diag., 4 graphs, 25 tables, 1960, 120 refs.

The present study includes 2 superfamilies of aspidobranch gastropods from the Permian of the southwestern United States. These are the Bellerophontacea, an abundant group having primitive bilateral symmetry, and the Patelacea, a rare group showing superficial, secondary bilateral symmetry. Where possible, species described from Permian outcrops outside North America have been tentatively assigned to the genera studied. Species currently assigned to the Pennsylvanian genera of Bellerophontacea in North America have been briefly reviewed. This is the first published summary of the bellerophontacean species in 60 years.

Following Knight's concept, the author interprets the Bellerophontacea as being prosobranch gastropods. The slit suggests 2 gills, and phyletic considerations imply that these gills may have restricted them to a firm bottom in fairly clear water. The Recent Patelacea have a clinging habit, and there is strong suggestive evidence that the Permian species had a similar habit.

The Permian Bellerophontacea do not show phyletic size increase through time. The size of Permian species shows no clear trends either in the fauna as a whole or in a few selected species studied in more detail. Size frequency distribution in 9 samples suggests that the occasional large specimen encountered is best considered as an extremely old individual. Size frequency studies may be of some use in differentiating between biocoenoses and thanatocoenoses.

Nine genera or subgenera of Bellerophontacea are described, one of which is new. Forty-five species of Bellerophontacea are discriminated. Thirty-three of these are considered new, 5 are redescribed, and 7 are discussed but not named. The Patelacea are less varied, with 2 genera and 7 species being recognized. Three species are new, 2 are redescribed, and 2 are unnamed. Occurrence data are presented for all species.--Auth.

3-139. Makarenko, D.E. THE FIRST OCCURRENCE OF *NERINEA INKERMANNICA* SP. N. IN THE MONTIAN STAGE OF THE CRIMEA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in translation, v. 124, no. 1-6, p. 142-143, 2 illus., Jan.-Feb. 1959, pub. Apr. 1960, ref.

Internal casts of a gastropod, *Nerinea inkermanica* have been found in friable yellow limestones of the Montian stage in the Crimea. This species occurs everywhere in the Crimea where outcrops of the limestone are found. It is concluded that the upper age limit of the family Nerineidae Zittel must be moved up from the Mesozoic to the Montian-Thasian [Paleocene] stages of the Cenozoic.--F. Manheim.

3-140. Roshka, V. Kh. THE VARIATION AND SYSTEMATIC POSITION OF THE NASSIDAE FROM THE LOWER SARMATIAN OF THE MOLDAVIAN S.S.R.: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 162-166, 2 figs., Jan.-Feb. 1959, pub. Apr. 1960, 7 refs.

Studies of individual variation in Nassidae from the lower Sarmatian [Miocene] of Moldavia have shown that the diagnostic features on the basis of which previous investigators have subdivided this family are statistically unreliable. It is concluded that the genera *Buccinum*, *Nassa*, *Lathyrus* and *Dorsanum* form a strongly variable single genus which should be called *Dorsanum duplicatum* (Sowerby).--F. Manheim.

3-141. Koroleva, M.N. NEW GENERA OF TRILOBITES FROM THE MIDDLE AND UPPER ORDOVICIAN OF CENTRAL KAZAKHSTAN: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 167-172, 4 illus., Jan.-Feb. 1959, pub. Apr. 1960, 12 refs.

A new trilobite subfamily, Koroleva, of the family Raphiophorida Angelin, 1854, and 3 new genera, *Ampyxinella* Koroleva, *Ovalocephalus* Koroleva, (family Cheiruridae Salter, 1853) and *Collis* Koroleva, family Trinucleidae Emmrich, 1839, are described.--F. Manheim.

3-142. Bock, Wilhelm. NEW EASTERN AMERICAN TRIASSIC FISHES AND TRIASSIC CORRELATIONS: Bock, Wilhelm, Geol. Center Research Ser., v. 1, 184 p., 55 figs., 22 pls., 1959, 68 refs.

The fishes of the eastern American Triassic and their taxonomy are reviewed and 9 new species added. Of the coelacanthids the genus *Rabdiolepis* Emmons and the genus *Osteolepiscus* (Schaeffer) are re-established to replace the genus *Diplotus* Newberry. The new species *Rabdiolepis gwyneddensis* and *Rabdiolepis striata* from the Lockatong formation are described. The palaeoniscid fishes are united in the new family Turseoidae, which is mainly based on the development of ossified vertebrae so far unknown in this large group. The new family comprises the genus *Turseodus* acutus Leidy, the new genus *Gwyneddichtis*, with the new species *G. major*, *G. minor*, and *G. gwyneddensis*, including the new genus and species *Eurecana gyrolepis*. The subholostean fishes are represented by the new species *Redfieldius obrai*, and the new genus and species *Rushlandia gilli*. The new species *Semionotus howelli* is added to the Semionotidae.

A list of the fishes of the eastern Triassic within a correlative scale and the present correlative status

of the Newark basin is broadly discussed. The 3 formations, the Stockton, Lockatong and Brunswick, are confirmed as being valid and not only facies.--Auth.

3-143. Kauffman, Erle G., and Robert V. Kesling. AN UPPER CRETACEOUS AMMONITE BITTEN BY A MOSASAUR: Michigan Univ., Mus. Paleontology, Contr., v. 15, no. 9, p. 193-248, 9 pls., 7 diag., 6 tables, July 1960, 28 refs.

An Upper Cretaceous ammonite, *Placenticerus* sp. cf. *P. whitfieldi* Hyatt, from the Virgin Creek member of the Pierre shale near Scenic, South Dakota, has been found bearing numerous perforations and impressions made by the teeth of an unidentified species of mosasaur of the subfamily Platecarpinae. From a composite of the patterns of tooth marks the dentition has been reconstructed and from the relationships of the upper and lower jaws in inflicting the bites certain inferences are drawn on the shape of the head, the structure and action of the jaws, and the diet of the mosasaur. The attacker had only 11 upper marginal teeth and 10 lower ones, fewer than any known mosasaur. Marks of pterygoid teeth indicate that the mosasaur tried to swallow the ammonite whole, but failing in this, it crushed the living chamber and squeezed or sucked out the living parts. It is concluded that the mosasaur was in the habit of eating ammonites, as the inferred method of attack shows familiarity with the prey. The large conical biting teeth and the wide intermaxillary angle appear to be adaptations for catching, killing, and swallowing or crushing big-shelled animals, such as ammonites. The inferred marine environment was comparable to the lower sublittoral zone of modern shelf seas.--M. Russell.

3-144. LARGE MIOCENE WHALE FOUND NEAR HAMPTON, VIRGINIA: GeoTimes, v. 5, no. 4, p. 29, 3 illus., Nov.-Dec. 1960.

A specimen of whale related to *Balaena*, collected from the upper part of the upper Miocene Yorktown formation, may be the largest fossil whale skeleton ever found. The skeleton was complete except for the smallest bones of one flipper. Barnacles and corals were found on some of the bones in growth position.--M. Russell.

3-145. Wilson, L.R., and R.T. Clarke. A MISSISSIPPIAN CHITINOZOAN FROM OKLAHOMA: Oklahoma Geology Notes, v. 20, no. 6, p. 148-150, pl., June 1960, 3 refs.

A chitinozoan belonging to the genus *Desmochitina* is reported from the Goddard shale. This is the first published description of a Mississippian chitinozoan and validates the youngest stratigraphic occurrence reported earlier.--L.R. Wilson.

3-146. Jousé, A.P. LES DIATOMÉES DES DÉPÔTS DE FOND DE LA PARTIE NORD-OUEST DE L'Océan Pacifique [Diatoms in Bottom deposits of the Northwest Part of the Pacific Ocean]: Deep-Sea Research, v. 6, no. 3, p. 187-192, map, 2 secs., table, Apr. 1960, 4 refs.; text in French.

In the deposits of the NW. Pacific Ocean, diatoms are found in abundance and in good preservation. In the vertical section of core samples, one can see changes in the composition of the diatoms and also in their quantity.

The diatoms of glacial periods can be distinguished by a colder assemblage than the present flora of the north Pacific. For the assemblage of the diatoms of the last interglacial period, the kind in the S.-boreal area are characteristic as opposed to the N.-boreal diatoms of the present flora of plankton in the N. Pacific.--Auth. (translated by L.M. Dane).

147. Langenheim, Ralph L., Jr., and others. CRETACEOUS AMBER FROM THE ARCTIC COASTAL PLAIN OF ALASKA: Geol. Soc. America, Bull., 71, no. 9, p. 1345-1356, map, sec., Sept. 1960, 5 refs.

Amber is widespread in association with coal and carbonaceous shale in probable equivalents of the Chandler and Prince Creek formations that crop out in the Kaolak River, Ketik River, and Kuk River valleys of the Alaskan Arctic Coastal Plain. Reported amber is ubiquitous in recent stream deposits and in the Pleistocene Gubik formation. Fossil insect inclusions are rare, but at least 4 species representing the families Heleidae, Empididae, Aphididae, and Ceraphronidae are present. The amber is generally associated with taxodiaceous fossils and is thus considered of taxodiaceous origin.

Marine fossils appear to be absent from the amber-bearing sequence. Thus biostratigraphic and time-rock correlation rests entirely on abundant plant megafossils and microfossils. Two floras occur with the amber. The older Kuk River flora is composed predominantly of gymnosperm remains and is considered Early Cretaceous. The younger Kaolak River flora, however, consists predominantly of angiospermous megafossils and gymnospermous microfossils. Thus it may be either Early or Late Cretaceous.--Auth.

148. Arnold, Chester A. A LEPIDODENDRID STEM FROM KANSAS AND ITS BEARING ON THE PROBLEM OF CAMBIUM AND PHLOEM IN PALEOZOIC LYCOPODS: Michigan, Univ., Mus. Paleontology, Contr., v. 15, no. 10, p. 249-267, fig., 4 pls., Aug. 1960, 19 refs.

A small *Lepidodendron* stem from a coal ball from the Cherokee group of the Pennsylvanian system of southeastern Kansas is described. The stem is distinguished by the presence of conspicuous raylike structures that extend across the secondary xylem and terminate in the primary xylem near the pith. Some of the tissues immediately external to the secondary xylem are exceptionally well preserved. Tissues showing histological characteristics of phloem can be recognized, but a band of internal rindermlike tissue, that at places is separated from the xylem only by a narrow layer of small-celled parenchyma might be mistaken for phloem if not critically examined. This tissue seems to be identical with that which Seward designated the "meristematic zone" and Weiss called "cambium" in *Lepidodendrois fuliginosus* and Scott called "phloem" in *L. schianus*. Seward's conclusion that the cambium does not form secondary phloem in the lepidodendrids is supported. The stem is named *Lepidodendron xizostelicum*, sp. nov., in allusion to the xylem under which is partly divided by conspicuous large raylike structures.--Auth. summ.

149. Wilson, L.R., and R.T. Clarke. SILICEOUS SPHERULES IN TRACHEIDS OF CORDAITEAN WOOD: Oklahoma Geology Notes, v. 20, no.

5, p. 106-110, 2 figs., May 1960, 2 refs.

Siliceous spherules similar to oölites occur in tracheids of cordaitean wood out of an Upper Pennsylvanian formation in Oklahoma. This occurrence of spherules appears to be unreported and in Oklahoma may serve as a stratigraphic marker.--L.R. Wilson.

3-150. Dorofeev, P.I. ON THE EARLY QUATERNARY FLORA AT THE VILLAGE OF ZHIDOVSHCHIZNA OF THE RIVER NEMAN: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 144-147, illus., Jan.-Feb. 1959, pub. Apr. 1960, 13 refs.

The flora of Pleistocene deposits in the vicinity of the city of Grodno, U.S.S.R. are described. It is concluded that the present flora are quite comparable with other Mindel-Riss floras of Europe and the Russian plain.--F. Manheim.

3-151. Kuznetsova, T.A. SPORE-POLLEN COMPLEXES OF THE PLIOCENE DEPOSITS OF THE LOWER KAMA: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 138-141, diag., table, Jan.-Feb. 1959, pub. Apr. 1960, 4 refs.

Spore and pollen studies from Pliocene deposits of the lower Kama were found to reveal insight into the climatic variations of the Pliocene in this area. Comparison with faunal sequences shows that stratigraphic correlation may be made on the basis of the spore and pollen assemblages alone. Such correlations are of particular importance in the fresh-water deposits, since these are devoid of shelly fauna.--F. Manheim.

3-152. Reeside, John B., Jr., and William A. Cobban. STUDIES OF THE MOWRY SHALE (CRETACEOUS) AND CONTEMPORARY FORMATIONS IN THE UNITED STATES AND CANADA: U.S. Geol. Survey, Prof. Paper 355, 128 p., 2 pls. (in pocket), 13 illus., 9 maps, 16 diags., 3 secs., 10 tables, 1960, 123 refs.

A series of 5 faunal assemblages is found in the beds that constitute a) the Mowry and Aspen shales and strata on Leeds Creek of the central part of the western interior of the United States, b) part of the Colorado shale of Montana and Alberta, and c) part of the Fort St. John group of Alberta and British Columbia. In the United States the deposits are largely the product of a long series of volcanic eruptions that are now represented by porcelanite, porcelanitic shale and sandstone, and bentonite distributed over the central and northern parts of the western interior. The Mowry and contemporary formations have yielded a flora, fresh-water invertebrates, marine invertebrates, an enormous amount of disarticulated fish remains, and a few bones of a variety of reptiles. Some of the marine invertebrates are the subject of the present paper. The fossils, except for the fish remains, are generally rare and poorly preserved, but at a few places calcareous concretions have furnished considerable numbers of well-preserved specimens, particularly ammonites. The speculation is offered that these assemblages of ammonites are fecal accumulations of a carnivore. Associated specimens of ammonites display a seemingly unusual range of variation in form and ornamentation and are interpreted as representing a small number of diversified species rather than a larger

number of genera and species. Five such species are accepted in the genus *Neogastrolites* and are considered to mark 5 faunal zones. The age of the deposits is accepted as latest Albian (latest Early Cretaceous), with the reservation that they may possibly belong to the earliest Cenomanian (earliest Late Cretaceous). Detailed description of representative stratigraphic sections and a list of all the localities that yielded fossils considered in the paper are given.

Five species of gastrolitine ammonites are recognized as marking 5 discrete assemblages and are assigned to *Neogastrolites*: in ascending order, *haasi* Reeside and Cobban, n. sp.; *cornutus* (Whitcaves); *muelleri* Reeside and Cobban, n. sp.; *americus* (Reeside and Weymouth); and *maclearni* Reeside and Cobban, n. sp. Faunal connection between the horizons of these assemblages cannot now be shown and inferences as to development are purely theoretical. In each species the wide range of form is broadly classified as including compressed costate, stout nodose, and subglobose spinose shells, though the relative amounts of each morphologic variety differ from level to level. The subglobose spinose portion is predominant in the oldest assemblage, the stout nodose portion in the second, and the compressed costate, *Gastrolites*-like portion, in the third and fourth, and the subglobose spinose appears strongly again in the fifth. Within each species 5 to 7 subordinate morphologic units are recognized as infrasubspecific variants and designated by letter. Each variant and some connecting forms are described and illustrated to show ontogenetic development as well as mature stages. As the genus *Neogastrolites* was based on a few moderately large shells of stout nodose morphology, the generic diagnosis has to be expanded to include the compressed costate variants, which attain large size, and the subglobose spinose variants, which remain

relatively small. McLearn's interpretation that *Neogastrolites* descended from *Gastrolites* by development of nodes is accepted.--Auth.

3-153. Seaman, David M. RECENT FOSSIL COLLECTING IN WESTERN PENNSYLVANIA: *Rocks & Minerals*, v. 35, no. 5-6, p. 214-216, May-June 1960, 6 refs.

Visits to exposures of Brush Creek limestone (Pennsylvanian) and Greenbrier limestone (Mississippian) in the vicinity of Pittsburgh, yielded a variety of invertebrate fossils, principally gastropods, brachiopods, crinoid stems, cup corals, and cephalopods. Within shrinkage cracks in siderite concretions in carbonaceous shale of the Brush Creek formation were found polymorphs of wurtzite as small, dark brown, hexagonal hemimorphic crystals associated with pyrite, chalcopyrite, sphalerite, and calcite. Over 100 species of invertebrates have been found in the Brush Creek limestone while over 50 species of invertebrates have been found in the Greenbrier limestone.--J. Sinkankas.

3-154. Korobkov, I. A. NEW DATA ON THE FAUNAS OF THE BUCHAK AND KIEV FORMATIONS OF SOUTH UKRAINE: *Akad. Nauk SSSR, Doklady, Earth Sci. Secs.*, in English translation, v. 124, no. 1-6, p. 65-66, Jan.-Feb. 1959, pub. Apr. 1960.

Twenty-one mollusc genera of middle Eocene age are listed as having been found in the Buchak formation of the S. Ukraine. The Kiev formation of the same area has, besides molluscs, an extensive foraminiferal and nummulite fauna. A list of species noted and studied is presented. The Kiev formation is correlated with middle and upper Eocene formations in western Europe.--F. Manheim.

6. GEOPHYSICS

See also: *Geologic Maps* 3-1, 3-3 through 3-10, 3-24 through 3-53, 3-58; *Geomorphology* 3-87; *Geohydrology* 3-273; *Fuels* 3-298; *Engineering Geology* 3-331.

3-155. Longman, I. M. A TECHNIQUE FOR THE NUMERICAL SOLUTION OF GEOPHYSICAL PROBLEMS: *Jour. Geophys. Research*, v. 65, no. 11, p. 3795-3800, 11 figs. incl. 8 graphs, Nov. 1960, 10 refs.

The theoretical analysis of problems in geophysics, and particularly in seismology, leads in many cases to solutions expressed in terms of integrals that cannot be evaluated by conventional numerical methods. The usual difficulties are connected with the oscillatory nature of the integrand and with the presence of one or more poles in the path of integration. In the simpler problems these difficulties can sometimes be circumvented by appropriate transformations in the complex plane, though this often involves lengthy analysis.

A method is presented for the direct and accurate evaluation of such solutions with a minimal use of algebraic manipulations. By way of illustration the method is applied to Lamb's problem with an oscillatory source.--Auth.

3-156. Heiskanen, W. A. THE LATEST ACHIEVEMENTS OF PHYSICAL GEODESY: *Jour. Geophys. Research*, v. 65, no. 9, p. 2827-2836, 5 figs. incl.

2 maps, 2 tables, Sept. 1960, 13 refs.

That the accuracy of computing the undulations in the geoid is not yet as high as is desired is not due to the method itself but to the lack of gravity data. The masses of the great formations are 85 to 90% isostatically compensated. The flattening ratio value $1/298.3$, obtained by the satellite method has also been obtained several times by gravity and arc-measuring methods. At the Institute of Geodesy, Photogrammetry and Cartography we have been conservative; we have used only the gravimetric method and have not extrapolated gravity anomalies more than $15''$ from the computation point.

Uotila obtained by spherical harmonic analysis third-order harmonics similar to those obtained by O'Keefe from satellite data. The undulations associated with the pear-shaped form are of the order of ± 15 m. O'Keefe's geoid heights at the N. and S. poles are brought about solely by the fact that the flattening value he used ($1/299.8$) does not correspond to the real facts.--Auth.

3-157. Corpacius, Alexander. HIRAN GEODESY AND PHOTOGRAPHIC OBSERVATIONS: *Jour. Geophys. Research*, v. 65, no. 9, p. 2837-2838, Sept. 1960, 2 refs.

New formulas are developed for computing the azimuth and distance between 2 Hiran ground stations.

data obtained from the photographs; orientation of the cameras is not necessary. There is a method of determining the orientation of Hiran network is obtained.--Auth.

158. Whitten, Charles A. HORIZONTAL MOVEMENT IN THE EARTH'S CRUST: Jour. Geophys. Research, v. 65, no. 9, p. 2839-2844, 5 figs. incl. 3 maps, Sept. 1960, 6 refs.

The conventional method for determining horizontal movement in the earth's crust has been to reserve networks of triangulation and compare the coordinates of the adjusted results. A new method of analysis of reobservations is presented. The changes in the angles in a network indicate the presence of strain or deformation within the crust. This type of analysis will also indicate small displacements which may occur along fault lines in an area of seismic activity. Results of the application of this technique to resurveys along the San Andreas fault in California are given in graphical form.--Auth.

159. Phillips, O.M. THE MEAN HORIZONTAL MOMENTUM AND SURFACE VELOCITY OF FINITE-AMPLITUDE RANDOM GRAVITY WAVES: Jour. Geophys. Research, v. 65, no. 10, p. 3473-3476, Oct. 1960, 7 refs.

Simple and exact expressions for 2 quantities of interest in the theory of finite-amplitude random gravity waves are presented. The first is the mean horizontal momentum of the wave motion per unit projected area. The second is the mean value of the horizontal component of the fluid velocity at the free surface, measured at a fixed location in the horizontal plane. These expressions are valid for either deep or shallow water, provided the water motion is rotational and the surface displacement $\xi(x, y, t)$ is either spatially periodic or a stationary random function of position (x, y) . From these primary results, expressions are readily found for these quantities in terms of the spectrum of the surface displacement ξ that are correct to order $(\overline{\nabla \xi})^2 \ll 1$.--Auth.

160. Andreev, B.A. THE RELATIONSHIP BETWEEN STRUCTURAL RELIEF AND GRAVITY ANOMALIES IN THE CASE OF SEVERAL DENSITY TERRACES: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, pp. 109-111, Jan.-Feb. 1959, pub. Apr. 1960, 8 refs.

A theoretical derivation is presented for the gravity effect of relief on the Mohorovičić discontinuity. It is stated that the derived expected regional anomalies on the order of 120 mgals. are in satisfactory agreement with the measured values of approximately 100 mgals. The gravitational effect of the Mohorovičić discontinuity should also determine the basic character of the regional gravity anomalies in the ocean basins, where the granitic layer is absent.--F. Manheim.

161. Nettleton, Lewis L., and Paul Elkins. GRAVITY OPERATIONS IN GUATEMALA: Geophysics, v. 25, no. 5, p. 1023-1034, 8 illus., 2 maps, Oct. 1960, ref.

This paper describes the logistics and field methods used for a gravity survey over a large concession in the NW. corner of Guatemala. Almost the entire network of lines for gravity stations was cut through heavy jungle, and heliports were cut at line

intersections. Logistics of the operation were heavily dependent on aircraft, using helicopters for transportation from camps to heliports, amphibian aircraft from main base to field camps and chartered DC-3 aircraft from Guatemala City to main camp. Field conditions and operations are illustrated by photographs. Statistics of operation and station production are included but no gravity data are shown.--Auth.

3-162. Longman, I.M. THE INTERPOLATION OF EARTH-TIDE RECORDS: Jour. Geophys. Research, v. 65, no. 11, p. 3801-3803, fig., Nov. 1960, 5 refs.

A method is presented whereby earth-tide gravity records can conveniently be interpolated. It is based on the theoretical rigid-earth gravity tide $g_0(t)$ and its time derivative. The possibility is envisaged that earth-tide gravity records for any station may be generated in their entirety by this method for any station for which a pair of constants has been determined.--Auth.

3-163. Stacey, F.D. MAGNETIC ANISOTROPY OF IGNEOUS ROCKS: Jour. Geophys. Research, v. 65, no. 8, p. 2429-2442, diag., 4 graphs, 3 tables, Aug. 1960, 21 refs.

A torque-meter method of measuring the magnetic anisotropy of rocks has been used in a study of a 1,050-ft. bore core from a Tasmanian dolerite sill. Each cylindrical specimen was suspended in a uniform field of 10.6 kilo-oersteds perpendicular to its axis, and the torque T exerted on it was measured at 10° intervals of the angle θ between a mark on the specimen and the direction of the field. Fourier analyses of the torque curves $T(\theta)$ yielded terms in $\sin 2\theta$ and $\sin 4\theta$, of which the first was due principally to shape alignment of the magnetic grains and the second to alignment of cubic crystallographic axes. The anisotropy of the bore core was found to be due to a slight but regular alignment of grain elongations with no regular alignment of crystallographic axes. Superimposed upon the pattern of anisotropy, statistical deviations from isotropy were observed in individual rock samples owing to the finite numbers of magnetic grains which they contained. The statistical effects were used to confirm the interpretation of the Fourier components of the torque curves and to estimate the mean elongation of the magnetic grains.

If the criterion of acceptability of a rock for paleomagnetic work is taken to be a maximum possible anisotropic deflection of remanent magnetism of 3° , then it is required that its anisotropy be less than 10%. Equations are given, expressing this criterion in terms of susceptibility anisotropy as well as torque-meter measurements. The anisotropy of the bore core, as well as of a few specimens of basalt and porphyry, is much too small to have influenced the paleomagnetic work which has been carried out on these rocks.--Auth.

3-164. Parry, L.G. THERMOMAGNETIC PROPERTIES OF BASALT FROM THE NEWER VOLCANICS OF VICTORIA, AUSTRALIA: Jour. Geophys. Research, v. 65, no. 8, p. 2425-2428, 2 graphs, table, Aug. 1960, 9 refs.

Curves of saturation magnetization vs. temperature have been obtained for a number of samples of basalt which have been used in the magnetostriction

experiments of Stott and Stacey. Magnetic minerals are identified and confirmed with X-ray powder photographs. Particular attention is given to one of the specimens in which the magnetic mineral is unchanged by heating in vacuum or in N but in which a new material is formed by heating in air.--Auth.

3-165. Howell, Lynn G., and others. A NOTE ON CHEMICAL MAGNETIZATION OF ROCKS: Geophysics, v. 25, no. 5, p. 1094-1099, 3 figs., 2 tables, Oct. 1960, 5 refs.

Previously obtained magnetic data for Silurian samples from Alabama are presented. Both the remanent vector and the plane of maximum susceptibility lie close to the bedding plane for this ore containing chemically formed hematite. Now, X-ray measurements show preferred crystal orientation of the hematite in agreement with the susceptibility anisotropy. On the other hand, samples from the Tertiary in Texas containing hematite resulting from chemical alteration show an appreciable preferred crystal orientation or susceptibility anisotropy. Thus, in this case there is no obvious relationship between the crystal growth of the hematite and the direction of the earth's magnetic field. It is suggested that stresses probably played a role in the crystal orientation in the Silurian Fe ore. An interesting chemical magnetization took place in the Weches of Tertiary age in Texas. The unaltered glauconite in the Weches is reversely magnetized whereas the limonite derived from the glauconite by weathering is normally magnetized.--Auth.

3-166. Stott, P.M., and F.D. Stacey. MAGNETO-STRICITION AND PALAEOMAGNETISM OF IGNEOUS ROCKS: Jour. Geophys. Research, v. 65, no. 8, p. 2419-2424, table, Aug. 1960, 14 refs.

Disks from a number of igneous rock specimens have been cooled from temperatures above the Curie points of their magnetic minerals under directed stresses of 500 and 1,000 kg./cm.². In all cases the thermoremanent magnetizations (TRM) measured after unloading coincided with the direction of the earth's field (0.6 oersted) to which they were exposed during cooling, and which was either at 66° or 46° to the axis of compression. A duplicate set of control specimens was given the same heat treatment but without the application of stress and found to be magnetized in the same direction. The scatter of measured directions of magnetization was the same for both sets of specimens, showing that any magnetostrictive deflections of magnetization must have been less than the experimental error, about 3°.

Another set of specimens was given isothermal remanent magnetization (IRM) by exposure to a field of 140 oersteds at an angle of 49° to the axis of directed stress. These specimens as well as a duplicate set of unstressed control specimens were also found to be magnetized in the direction of the inducing field.

The experiments show that the application of directed stresses up to 1,000 kg./cm.² during the magnetization of igneous rocks containing a variety of magnetic mineral aggregates does not deflect their magnetic moments. The same result was obtained with a rock in which the magnetic mineral was changed by heating in air while under directed stress.

It is concluded that the natural magnetic moments of isotropic igneous rocks are not normally deflected by magnetostrictive effects.--Auth.

3-167. Wescott, E.M., and V.P. Hessler. THE EFFECT OF TOPOGRAPHY AND GEOLOGY ON TELLURIC CURRENTS: Alaska, Univ., Geophys. Inst., Sci. Rept. no. 3, 30 p., 33 figs. incl. illus., maps, diags., charts, logs, tables, Apr. 1960, 25 refs.

The electric field vectors E , associated with telluric currents are known to vary in comparative magnitude and principal direction at different locations. Large differences in the vectors from several Alaskan stations prompted a study to determine what effect topography and geology have on the telluric field, and in particular what variations are found in the vicinity of the University of Alaska, Geophysical Institute recording site. Seventeen field sites were established and recordings made for comparison of simultaneous disturbances with the Institute records. The results of this study show that the comparative magnitude may change by a factor of 5 and the principal direction may range over 33°, and in one extreme case 70° in the area.

Model studies using a resistor network were made to determine the effects of some simple topographic and conductivity configurations upon the telluric field. Surface resistivity measurements were made at each recording location for interpretation of the field data. Some of the interesting field results are explained on the basis of the model studies and the resistivity measurements. The principal direction at the Institute site agrees within 10° of the regional principal direction, but the magnitude is abnormally high compared to the regional values.--Auth.

3-168. Hessler, V.P., and E.M. Wescott. EARTH CURRENT ACTIVITY AT COLLEGE ALASKA 1956-1958: Alaska, Univ., Geophys. Inst., Sci. Rept. no. 2, 17 p., 13 figs. incl. diags., graphs, logs, 36 tables, Feb. 1960, 18 refs.

This report presents 3-hourly scalings of earth current activity for the entire period from Jan. 1956 through Dec. 1958. The data are analyzed for diurnal, seasonal, and yearly averages of activity. There is a pronounced diurnal variation in activity with a maximum at local midnight. The principal direction of the earth current disturbances at College is about N. 33° W. and is so constant that total activity in mv./km. can be determined with sufficient accuracy from N.-S. records. Earth current activity has a high correlation with magnetic activity and other polar ionospheric phenomena. The average of 6 monthly correlation coefficients between magnetic daily A figures and earth current average daily mv./km. is .948. Thus, the earth currents constitute a useful indicator of ionospheric activity.--Auth.

3-169. Hessler, V.P. EARTH CURRENT ACTIVITY AT COLLEGE, ALASKA, JULY 1959: Alaska, Univ., Geophys. Inst., Sci. Rept. no. 4, 5 p., diag., logs, 2 tables, June 1960, 11 refs.

This report presents College N.-S. earth current records for the month of July 1959. The scale of 1 in. per hr. permits detailed scaling directly from the reproductions in the report. Scalings of hourly range in amplitude and rapid fluctuation activity are given. The amplitude scalings are also presented as curves together with average curves for a period of several years to show the relative magnitudes of the July 1959 activity. The earth current always displays much more pronounced fine structure than the corresponding geomagnetic activity.--Auth.

170. Niblett, E.R., and C. Sayn-Wittgenstein. **VARIATION OF ELECTRICAL CONDUCTIVITY WITH DEPTH BY THE MAGNETO-TELLURIC METHOD**: *Geophysics*, v. 25, no. 5, p. 998-1008, 5 graphs, Oct. 1960, 7 refs.

An apparatus has been installed at the Dominion Observatory Research Station at Meanook, Alberta, for the continuous recording of earth potentials. The theory due to Cagniard and others, in which relative amplitudes of horizontal components of electric and magnetic fields are used to interpret the subsurface structure, is applied in a modified form, to data from the Meanook records. Values of electrical conductivity between depths of 10 km. and 100 km. are estimated and found to vary roughly between 10^{-13} and 10^{-14} e.m.u.--Auth.

171. Onodera, Seibe. **THE KERNEL FUNCTION IN THE MULTIPLE-LAYER RESISTIVITY PROBLEM**: *Jour. Geophys. Research*, v. 65, no.11, 3787-3794, Nov. 1960, 16 refs.

An explicit expression in terms of symmetric auxiliary functions is developed for the kernel function in the integral representation of the potential at the surface of a medium composed of homogeneous, isotropic, horizontal layers. As an example, the explicit form is given for the case of 7 layers.--Auth.

172. Hatherton, T. **ELECTRICAL RESISTIVITY OF FROZEN EARTH**: *Jour. Geophys. Research*, v. 65, no. 9, p. 3023-3024, graph, Sept. 1960, 2 refs.

Apparent resistivities of permanently frozen ground were measured at 2 stations in Antarctica. At Scott Base, resistivities near the surface are about 100 ohm-m. in one place and about 300 ohm-m. in another; apparent resistivities at depth are 1,500-2,000 ohm-m. At the time of measurement the ground temperature at 15 cm. was -5°C . and the temperature below 10 m. about -21°C . At Hallett station the resistivity near the surface was only about 30 ohm-m. and at the greatest electrode separation (30.5 m.) it was about 400 ohm-m.

These d-c resistivities are surprisingly low for frozen ground. They are similar to the values measured by Cook on synthetic salty ice and frozen earth.--D.B. Vitaliano (courtesy Geophysical Abstracts 82-213).

173. Meidav, Tsvi. **AN ELECTRICAL RESISTIVITY SURVEY FOR GROUND WATER**: *Geophysics*, v. 25, no. 5, p. 1077-1093, 12 figs. incl. 3 maps, 3 graphs, 3 tables, Oct. 1960, 9 refs.

An electrical resistivity survey was carried out in Grundy, Chariton, and Carroll counties, Missouri, in connection with a ground-water project of the Missouri Geological Survey. The aim of the project was to locate buried channels under the glacial cover.

The resistivity data obtained was interpreted both empirically and quantitatively. The empirical method was found to be satisfactory wherever the uniformity of electrical properties was maintained by either the glacial cover or bedrock, and the resistivity contrast was high. The quantitative technique used most commonly in this study was Spicer's modification of Hummel's procedure, used in conjunction with standard 2, 3, and 4-layer master curves. The limitations of the quantitative methods of interpretation are indicated in a series of resistivity distribution curves.--Auth.

3-174. Braun, T.H., and George Y. Wheatley. **ELECTRICAL ANALOG APPROACH TO DIPMETER COMPUTATION**: *Geophysics*, v. 25, no. 4, p. 928-938, 2 illus., chart, 4 diag., Aug. 1960, 15 refs.

An electrical analog instrument has been developed to calculate dip and strike from continuous dipmeter logs. The particular model described is designed specifically for the Schlumberger CDM-P, or Poteclinometer, logs and it can be used with hole deviations of up to 36° .

Every control on this instrument corresponds to one of the recorded parameters of the dipmeter log. It is thus easy to see the effect of any one parameter on the resolved dip and strike. The instrument is portable and can therefore be used at the well site, if necessary, to make on-the-spot decisions regarding further drilling operation after a dipmeter log has been run. No elaborate training in procedure is required.

The rapidity with which the computations can be made also permits a large number of levels to be computed. This frequently results in more accurate information and a considerable saving in computation expense.--Auth.

3-175. Doll, H.G., and others. **SUGGESTIONS FOR BETTER ELECTRIC LOG COMBINATIONS AND IMPROVED INTERPRETATIONS**: *Geophysics*, v. 25, no. 4, p. 854-882, 12 figs. incl. charts, graphs, logs, Aug. 1960, 4 refs.

In modern electrical logging, several resistivity measuring devices are now available or are under development which cover a wide range of radial investigations. In order of increasing penetration, they include:

a) The proximity log (a new tool for recording formation resistivity close to the wall of the hole).

b) A new type of laterolog having a shallow investigation and adapted for simultaneous recording with an induction log.

c) An induction log appropriate for moderate invasion (e.g., the present 5FF40).

d) A deep investigation induction log (e.g., the new 6FF40).

All these devices have a high vertical resolution, and their readings are practically unaffected by the mud column.

This paper deals essentially with the case of logging in fresh mud. A discussion is presented of the information which can be obtained on saturation, when combinations of respectively 2, 3, or 4 of the above listed devices are used. The general case where nothing is known about the depth of invasion is first considered. The combination of the laterolog and deep investigation induction log, when compared with SP curve, permits visual recognition of most salt-water-bearing beds. With the addition of the proximity log and medium investigation induction log the effect of invasion can be estimated, and the distinction of practically all water-bearing and oil-bearing beds is made possible. The possible presence of a low resistivity zone beyond the invaded zone can be detected and accounted for. The ratio R_{XO}/R_t can be determined, from which an estimation of saturation can be made. The value of R_t can be furthermore derived, which gives another way of computing saturation if the formation factor can also be obtained, for example from the porosity given by a sonic log.

In these combinations the 16 in. normal can be used instead of the laterolog, when bed resistivities are not too high. In those regions where the depth

of invasion is known from local experience, one or even two of the above devices can be omitted. The advantage of a logarithmic resistivity scale for a convenient and rapid visual interpretation of the logs is explained. Charts to be used in the above procedures are shown, and the discussion is illustrated with field examples.--Auth.

3-176. Wyllie, M. R. J. LOG INTERPRETATION IN SANDSTONE RESERVOIRS: *Geophysics*, v. 25, no. 4, p. 748-778, 13 figs. incl. diagrs., graphs, logs, Aug. 1960, 34 refs.

o By comparison with carbonate rocks sandstones are texturally homogeneous; in consequence the interpretation from well logs of the fluid content and physical properties of sandstones is relatively simple. From an exploration standpoint one significant fact must be gleaned from the log: will the formation of interest produce oil or gas? The precise porosity and thickness of the formation and its exact hydrocarbon saturation are, initially, secondary considerations.

Some of the principal difficulties involved in determining interstitial water resistivity, porosity and formation resistivity are examined. It is confirmed that the so-called "low zone" significantly decreases the resistivity of an oil-bearing sand when this resistivity is found from an induction log. Theory and laboratory experiment confirm that diffusion and convective mixing of the filtrate and interstitial water do little to mitigate the problem. It is suggested that future correction charts for induction logs recognize this fact.

New data bearing on the dirty sand problem show that if formations contain interstitial clay the interpretation procedure suggested by A.J. de Witte is substantially correct. It is pointed out that the real problem is to decide the manner in which the clay content of a typical dirty sand is disposed.

Measurements on the effect of the porosity of sandstones on the difference between velocities through them when dry and fully water-saturated disclose an interesting paradox: the velocity difference is a maximum when the porosity is a minimum. Significant differences in velocity between gas- and water-saturated sandstones are not to be expected in the porosity range of practical significance.--Auth.

3-177. Chombart, Louis G. WELL LOGS IN CARBONATE RESERVOIRS: *Geophysics*, v. 25, no. 4, p. 779-853, 23 figs. incl. 5 illus., chart, sec., profile, diagrs., graphs, logs, Aug. 1960, 93 refs.

Modern well logs can play an important, often decisive role in the evaluation of carbonate reservoirs, and in well completions therein. To do so however, the logs must be selected and interpreted with due regard for the specific rock "types" and pore structures encountered by each well.

Indeed, the basic condition stated applies to all evaluation and completion techniques now in use or conceivable. It becomes vitally important in carbonate reservoirs, however, because of their extraordinary heterogeneity. Characteristically, these reservoirs exhibit significant, often extreme, and always unpredictable variations in pore structure, pore size distribution, and fluid content, within very short distances, in any direction.

To cope with such a reservoir, an evaluation and logging program adhering to certain principles is most likely to yield valid results and insure better completions and greater ultimate recovery, at mini-

mum cost. First, in every well, the cuttings or cores should be described precisely as to rock types and depths. Second, any techniques used should permit the largest possible number of determinations through the reservoir, so that any existing relationships between pore size distribution, porosity, and water saturation may be established on a sound statistical basis. Among logging devices, "focusing" tools meet this requirement best. Third, starting very early in the development of the reservoir, the latter should be cored and logged in key wells, the cores subjected to capillary pressure and other petrophysical tests, and all potentially diagnostic logs run and analyzed in the light of all other data. Fourth, in non-key wells, the logging program should include only those logs proved most reliable in the key wells for the pore structures encountered and the data desired (usually porosity, water saturation, net feet of pay).--Auth.

3-178. Johnson, Hamilton M. DUTIES OF A LOGGING CO-ORDINATOR IN AN OPERATING COMPANY: *Geophysics*, v. 25, no. 4, p. 734-747, 7 figs. incl. diagrs., graph, logs, Aug. 1960, 50 refs.

A well logging coordinator for an operating oil company is often considered to be only a "log analyst," but quantitative log analysis should constitute only a small part of his duties. Associated with the actual analysis are the compilation and preparation of auxiliary reservoir data, field research and evaluation of new tools and methods designed to solve problems of particular areas and conditions, the coordination of logging programs with drilling programs and the development of interpretation techniques.

For the company to achieve the most efficient use of its logging dollar, the coordinator must maintain a constant check on log quality, conduct schools on formation evaluation for field personnel and serve as an advisor on unitization committees.

It is helpful to him realizing this program to have a logging research group within the over-all research effort of the operating company to aid him in specific problems and to help him keep abreast of industry-wide research.--Auth.

3-179. Willmore, P. L. THE DETECTION OF EARTH MOVEMENTS: *Canada, Dominion Observatory, Contr.*, v. 3, no. 26, p. 230-276, 14 figs. incl. illus., diagrs., graphs, [1960?], 19 refs.

In seismology one is not concerned with the motion of the earth as a whole, but rather with movements of a selected point relative to the center of gravity. Any such motions necessarily represent distortions of the earth, and as such will be associated with rotation or tilt, with changes in g (due to the changing figure of the earth) and with stress and strain. A record which shows any of these parameters as a function of time will serve to describe the earth movement, and any instrument used for obtaining such records may properly be called a "seismograph."

By far the most widely used type of seismograph consists of a weight, mounted on resilient supports so that any movement of the ground will displace the frame of the instrument relative to the mass. These relative displacements are detected by lever trains or by electrical "transducers," and ultimately recorded on moving paper or on some other recording medium. In seismographs of this type any change of acceleration acting on the frame in a direction along which the mass is free to move will disturb the system, and we can therefore draw no distinction in

principle between ordinary seismographs, which are designed primarily to detect earth movements, and the gravimeters and tiltmeters which are supposed to record components of acceleration. In practice, a broad distinction can be drawn in terms of the duration of the phenomena which are observed. Both classes of instrument can detect accelerations of the order of 10^{-5} cm./sec.², but the seismographs are designed to respond most strongly to accelerations which have an oscillatory character with periods of less than a few minutes, whereas tiltmeters and gravimeters are designed to record accelerations which persist for hours or more.--From introd.

This paper deals with the representation of seismograph response, theory of pendulum seismographs, seismographs measuring stress and strain, and the further development of seismometry.

3-180. Healy, John H., and Frank Press. TWO-DIMENSIONAL SEISMIC MODELS WITH CONTINUOUSLY VARIABLE VELOCITY DEPTH AND DENSITY FUNCTIONS: *Geophysics*, v. 25, no. 5, p. 987-997, 11 figs. incl. illus., sec., graphs, Oct. 1960, 4 refs.

A method for fabricating 2-dimensional ultrasonic seismic models with variable velocity and density is described. The method is justified theoretically. It is tested by comparing the experimental and theoretical dispersion of Rayleigh waves in a model of a 2-layered earth crust.--Auth.

3-181. U.S. Coast and Geodetic Survey. PRINCIPLES UNDERLYING THE INTERPRETATION OF SEISMOGRAMS. Prepared originally by Frank Neumann: Its: Spec. Pub. no. 254, rev. (1959) ed., 42 p., 17 figs. incl. charts, seismograms, diags. (2 in pocket), 1960.

This printed edition of *Principles Underlying the Interpretation of Seismograms* was prompted by a steady demand for the edition first issued in mimeographed form in 1930. Many excellent textbooks have been issued on seismology since then but few if any have covered the interpretation of earthquake seismograms in sufficient detail to satisfy the requirements of a seismograph station director, the student who is beginning his career as a seismologist, or the amateur seismologist. This publication is designed to fulfill that need.

Although adequate initial interpretation of seismograms is not often achieved at stations where seismology is a subordinate activity, such stations nevertheless perform an invaluable service in obtaining seismographic records and transmitting preliminary data to established processing centers. There, combined with data from other stations, they are used to furnish authentic information on the locations of all important earthquakes. Not only is the scientific world and the public thus furnished immediate information on current earthquakes, but the program provides basic data from which correct interpretations can be made by station directors who furnish the preliminary data. *Principles Underlying the Interpretation of Seismograms* is designed primarily for seismologists working in this level of competence.

Because of the great success attained in the past 2 decades with seismographs that give emphasis to the short-period waves inherent in earthquake vibrations, this edition includes discussions of these instruments and their records. Such records are radically different in appearance from standard

records which attempt to obtain an over-all period coverage by emphasizing intermediate period waves. This, unfortunately, slight the effective recording of the short-period and long-period waves that lie at opposite ends of the teleseismic period spectrum.

The student can become proficient in analysing seismograms only by first absorbing a certain amount of fundamental background information pertaining to the origin and transmission of seismic waves and the recording characteristics of the principal types of seismographs now used in the long-range detection of earthquakes. This necessarily includes the fundamentals of earth structure since seismic wave propagation is dependent on the nature of the transmitting medium. In following this broad plan only fundamentals are covered and an effort is made to draw a distinction between what constitutes routine interpretation and what may be considered research.--From introd.

Topics covered include seismic waves and earth structure, response of seismographs to seismic waves, travel-time tables and charts, interpretation of seismograms.

3-182. Meidav, Tsvi. NOMOGRAMS TO SPEED UP SEISMIC REFRACTION COMPUTATIONS: *Geophysics*, v. 25, no. 5, p. 1035-1053, 10 figs., Oct. 1960, 4 refs.

Nomographic solutions of a number of equations commonly employed in seismic refraction work are presented. The equations solved are: 1) depth to a second layer, by means of the critical distance formula; 2) the critical angle and offset distance formulas; 3) true velocity of bedrock from the apparent up- and down-dip velocities; 4) depth to a second layer by means of the intercept-time formula. This last solution is also applied to a) finding the throw of a fault and b) depth to an irregular second layer at each seismometer beyond the critical distance. Geometry of each of the nomograms is explained. Procedure for using each of the nomograms is described.--Auth.

3-183. Tocher, Don, and William L. Baker. EARTHQUAKES IN NORTHERN CALIFORNIA, NEVADA, AND OREGON AND REGISTRATION OF EARTHQUAKES AT: BERKELEY, MOUNT HAMILTON, PALO ALTO, SAN FRANCISCO, FERNDALE, FRESNO, MINERAL, ARCATA, RENO, CORVALLIS, SHASTA, AND MANZANITA LAKE, FROM APRIL 1, 1958 TO JUNE 30, 1958: *California, Univ., Bull. Seismog. Sta.*, v. 28, no. 2, p. 33-76, map, 1960.

3-184. Tocher, Don. EARTHQUAKES IN NORTHERN CALIFORNIA, NEVADA, AND OREGON AND REGISTRATION OF EARTHQUAKES AT: BERKELEY, MOUNT HAMILTON, PALO ALTO, SAN FRANCISCO, FERNDALE, FRESNO, MINERAL, ARCATA, RENO, CORVALLIS, SHASTA, AND MANZANITA LAKE FROM JULY 1, 1958 TO SEPTEMBER 30, 1958: *California, Univ., Bull. Seismog. Sta.*, v. 28, no. 3, p. 79-126, map, 1960.

3-185. Tocher, Don, and William L. Baker. EARTHQUAKES IN NORTHERN CALIFORNIA, NEVADA, AND OREGON AND REGISTRATION OF EARTHQUAKES AT: BERKELEY, MOUNT HAMILTON, PALO ALTO, SAN FRANCISCO, FERNDALE, FRESNO, MINERAL, ARCATA, RENO, CORVALLIS, SHASTA, AND MANZANITA LAKE, FROM OCTOBER

1, 1958 TO DECEMBER 31, 1958: California, Univ., Bull. Seismog. Sta., v. 28, no. 4, p. 129-173, map, 1960.

3-186. Aki, Keiiti. INTERPRETATION OF SOURCE FUNCTIONS OF CIRCUM-PACIFIC EARTH-QUAKES OBTAINED FROM LONG-PERIOD RAY-LEIGH WAVES: Jour. Geophys. Research, v. 65, no. 8, p. 2405-2417, 8 figs. incl. map, 2 tables, Aug. 1960, 34 refs.

The source functions of 53 shocks of the circum-Pacific belt were obtained by a method of equalization applied to Rayleigh waves in the period range of 35 sec. to 150 sec. recorded at the Seismological Laboratory, Pasadena, California. The source function was interpreted in terms of the direction of forces at the source. The interpretation was checked by additional information concerning the earthquake as well as by an error analysis. The horizontal forces deduced from the source function showed a systematic geographic distribution, which favors Benioff's hypothesis on the circum-Pacific tectonics. The vertical forces are found to be mostly directed upward on the oceanic side.--Auth.

3-187. Gilbert, Freeman, and Leon Knopoff. SEISMIC SCATTERING FROM TOPOGRAPHIC IRREGULARITIES: Jour. Geophys. Research, v. 65, no. 10, p. 3437-3444, Oct. 1960, 3 refs.

An approximation, similar to the Born approximation, is developed for scattering of seismic waves by an irregular surface. It is assumed that the magnitude and slope of the irregularity are small. The irregularity is replaced by an equivalent stress distribution so that the problem is reduced to Lamb's problem for distributed surface sources; the latter problem can be solved by convolution methods. As examples, the problems of the scattering of plane P waves, plane S waves, and surface Rayleigh waves are treated. Solutions are obtained in terms of integrals of functions that arise in the theory of Lamb's problem for isolated surface line sources. The example of the scattering from a mountain with plane sides is worked out in detail. The result is valid for pulses whose durations are long compared with the vertical travel time across the irregularity and short compared with the horizontal travel time across the irregularity.--Auth.

3-188. Dorman, James, and David Prentiss. PARTICLE AMPLITUDE PROFILES FOR RAY-LEIGH WAVES ON A HETEROGENEOUS EARTH: Jour. Geophys. Research, v. 65, no. 11, p. 3805-3816, 7 figs. incl. profiles, graphs, table, Nov. 1960, 14 refs.

The relationship between vertical and horizontal particle amplitude and depth for Rayleigh waves was obtained for several models of a heterogeneous, solid half-space using a new computing program for the IBM 650. The data show how the well-known characteristics of Rayleigh wave motion on a homogeneous half-space are modified in the common case in which compressional and shear velocities increase downward in the earth and also in the case in which a low-velocity region such as the mantle or asthenospheric low-velocity channel exists.

Theoretical particle amplitude profiles and dispersion curves, computed on the basis of borehole measurements of compressional and shear velocities made by Dobrin, Simon, and Lawrence, are compared

with data on explosion-generated Rayleigh waves of 4 to 8 c.p.s. recorded by them in the borehole. Observed particle trajectories and computed amplitude profiles are in good agreement except in the upper 10 ft., where the very large horizontal amplitudes predicted by theory, particularly for short periods, are not shown in the field observations.

Particle amplitude profiles based on Gutenberg's model of the mantle are given for a broad spectrum of mantle Rayleigh wave and long-period crustal Rayleigh wave frequencies. These data show that the heterogeneous character of the mantle cannot be neglected in the problem of crustal Rayleigh wave dispersion. They also show that no "captured waves" or "channelled waves" of unusual character exist in the Rayleigh mode. Instead, particle motion profiles for the heterogeneous earth differ only slightly from the profile for Rayleigh waves on a homogeneous half-space throughout the spectrum of this mode.--Auth.

3-189. Satô, Yasuo, and others. LOVE WAVES IN A HETEROGENEOUS, SPHERICAL EARTH. PART I. THEORETICAL PERIODS FOR THE FUNDAMENTAL AND HIGHER TORSIONAL MODES: Jour. Geophys. Research, v. 65, no. 8, p. 2395-2398, graph, table, Aug. 1960, 15 refs.

Free periods of torsional oscillation have been calculated for the Jeffreys-Bullen and Lehmann I earth models. Results are given for the first 9 radial modes and for azimuthal modes up to $n = 44$. The calculation allows for sphericity, an arbitrary number of discontinuities, gradients within each shell, and a liquid core.--Auth.

3-190. Satô, Yasuo, and others. LOVE WAVES IN A HETEROGENEOUS, SPHERICAL EARTH. PART 2. THEORETICAL PHASE AND GROUP VELOCITIES: Jour. Geophys. Research, v. 65, no. 8, p. 2399-2404, 4 graphs, table, Aug. 1960, 23 refs.

Love wave phase and group velocities have been calculated for the first 14 radial modes for the Jeffreys-Bullen and Lehmann I models. Sphericity, an arbitrary number of discontinuities, gradients within each shell, and a liquid core have been taken into account. A new result is the prediction of maximum values of group velocity of about 7.5 km./sec. for all the higher modes and the relation of these maxima and the period cutoffs to travel-time results.--Auth.

3-191. Hunkins, Kenneth L. SEISMIC STUDIES OF SEA ICE: Jour. Geophys. Research, v. 65, no. 10, p. 3459-3472, 16 figs. incl. diag., graphs, 8 tables, Oct. 1960, 20 refs.

During the International Geophysical Year, elastic wave propagation in sea ice was studied near Drifting Station Alpha in the central Arctic Ocean. Velocities of longitudinal and transverse waves in ice showed a marked seasonal change which is largely attributable to variations in ice temperature. With these velocity data, plus additional data on density, the calculation of various elastic constants of sea ice throughout the year can be made.

Flexural wave dispersion was investigated for different ranges, charge sizes, and ice parameters. Experimental results are in general agreement with theory. Thickness, as determined from the dispersion of flexural waves and from air-coupled flexural waves, is characteristically lower than that found by direct measurement.

Both longitudinal and flexural waves crossing leads suffer severe attenuation. Transmission across leads shortened the duration of the normal air-coupled flexural wave train.--Auth.

192. Schwind, Joseph J., and others. **PS CONVERTED WAVES FROM LARGE EXPLOSIONS:** Jour. Geophys. Research, v. 65, no. 11, p. 3817-3824, 1960, 1 fig., 1 map, 4 tables, Nov. 1960, 5 refs.

Four seismograms obtained during 1958 and 1959 from large quarry blasts at Promontory (1,221,000 and 2,138,000 lb. of explosive) and Lakeside, Utah (1,500,000 lb.), and the underground Blanca nuclear explosion (38,000,000 lb. equivalent) near Mercury, Nevada, were studied to ascertain whether converted waves of PS type were recorded and, if so, whether they could be used in an analysis of earth crustal layering, as proposed by Andreev in 1957. The PS converted wave is presumed to be composed principally of the SV-type wave (vertically polarized shear wave) and to result from the conversion of energy from the parent compressional P wave at the interface between 2 crustal layers of contrasting seismic velocity.

The method of analysis consisted in computing theoretical times of arrival for PS converted waves based on crustal layering and velocities in the area as determined from refraction seismic studies by Berg, Cook, and Narans, by plotting the radial horizontal component versus the vertical component of velocity of ground motion over appropriate time intervals, and by comparing amplitudes and frequencies of the PS converted waves with the amplitude and frequency of the parent P wave.

Arrivals, provisionally interpreted as PS converted waves, were detected on the traces of both the radial horizontal-component seismometers (2 c.p.s. natural frequency) and the vertical-component seismometers (2 c.p.s.). The amplitude of the PS converted waves was usually several times greater than that of the first arrival of the P wave. The successively later arrivals of PS converted waves from successively deeper horizons showed progressively greater ground-velocity amplitudes, as found by Andreev on earthquake seismograms, but some variance from this generalization was found. The frequencies of the various PS converted wave arrivals were approximately the same as those of the parent P wave, between 5 and 10 c.p.s.

The crustal layering, which was determined by using the times of arrival of the PS converted waves, compared favorably with that given by Berg, Cook, and Narans for this area. The computed depths of the successive layers were: 5.5, 9.7, 16, and 26 km. at Neola, Utah (epicentral distance of about 245 km. from Lakeside blast); 12, 26, and 31 km. at Gold Hill, Utah (173 km. from Promontory); 8.6, 24, and 29 km., also at Gold Hill (379 km. from Blanca); and 12, 22, and 31 km. at Elko, Nevada (279 km. from Promontory).--Auth.

193. Johnson, Gerald W. **APPLICATION OF NUCLEAR EXPLOSIONS AS SEISMIC SOURCES:** California, Univ., Radiation Lab., [Pub.] UCRL-6030-T, 51 p., 2 illus., 2 maps, 2 profiles, sec., diag., 5 tables, July 1960, 27 refs.

Nuclear explosions offer definite advantages over chemical explosions when higher yields are desired including a cheaper energy release. With greater precision in timing and location afforded by nuclear explosions, more refined analyses of wave anomalies

should be possible, leading to more definitive conclusions on the earth's interior. Success in sealing off underground nuclear explosions at the Nevada Test Site point to the feasibility of this method in seismic research. The precise yield, time, and location of past nuclear explosions conducted by the United States are given.--M. Russell.

194. Griggs, David T., and Frank Press. **PROBING THE EARTH WITH NUCLEAR EXPLOSIONS:** California, Univ., Radiation Lab., [Pub.] UCRL-6013, 40 p., 6 diags., 2 tables, July 1960, 20 refs.

Progress in seismology is reviewed with emphasis on the usefulness of past nuclear weapon tests in determining the internal structure of the earth. The advantages of using large chemical explosions and future nuclear explosions detonated under the Plowshare program as controlled energy sources for carefully instrumented seismological experiments are discussed. Finally, an international program of explosions for seismological research is proposed, and specific suggestions are made for attacking several outstanding problems in seismology by means of chemical and clean nuclear explosions and the instrumentation network proposed at Geneva for nuclear test detection.--Auth. summ.

195. Pomeroy, Paul W., and Jack E. Oliver. **SEISMIC WAVES FROM HIGH-ALTITUDE NUCLEAR EXPLOSIONS:** Jour. Geophys. Research, v. 65, no. 10, p. 3445-3457, 10 figs. incl. 3 graphs, 2 tables, Oct. 1960, 12 refs.

Seismic waves of long period were well recorded at epicentral distances as great as 9,300 km. from 2 high-altitude nuclear explosions, Teak and Orange, which were fired in the Johnston Island area on Aug. 1 and 12, 1958, respectively. Seismic waves recorded at Honolulu, at a distance of approximately 1,300 km. may be divided into 3 types: 1) a normally dispersed, oceanic Rayleigh wave train in which the wave periods decrease from about 35 to 14 sec. as the corresponding velocities decrease from about 4.1 to 1.6 km./sec.; 2) an inversely dispersed, oceanic Rayleigh wave train in which the wave periods increase from about 6 to 10 sec. as the corresponding velocities decrease from about 1.3 to 1.0 km./sec.; 3) a T-phase consisting of waves with periods less than about 0.5 sec. and corresponding to a velocity of 1.47 km./sec.

From the normally dispersed train, group velocities of waves in the 35- to 14-sec. period range were computed for the 2 paths, both of which traverse primarily a typical deep oceanic basin. These group-velocity data plus possible corresponding phase-velocity data are compared with theoretical values for oceanic structures. The inversely dispersed train, although predicted by classical theory, has not been observed in seismograms from (natural) earthquakes.

Surface waves of long period were recorded at Palisades, New York, from both of the high-altitude nuclear explosions, and these waves have amplitudes comparable to those generated by the larger of the nearsurface explosions in the Marshall Islands. Special instruments at Palisades, not operated for Teak, indicate that amplitudes for the long-period body waves from Orange are comparable to those from the Marshall Islands shots. In contrast, seismic body waves of short period are apparently generated much more efficiently by nearsurface explosions than by high-altitude explosions.--Auth.

3-196. Broding, R. A., and J. L. Poole. **COLLECTION AND PROCESSING OF DIGITIZED ACOUSTIC LOG DATA:** *Geophysics*, v. 25, no. 4, p. 939-947, 8 figs. incl. illus., diags., log, table, Aug. 1960, 3 refs.

The mathematical processes involved in making acoustic logs useful for the geophysicist or production analyst have prompted the handling of log data by digital means. Digital punched tape logs from retraced analog recordings as well as digital recordings made by punching tapes directly from the recording galvanometer signal obtained during a logging survey are being used as input to electronic computers. These computers can be programmed to perform the normal computations now used in data reduction. This process yields higher precision data and allows computational procedures to be performed that previously were considered burdensome or tedious. The technique is attractive in preparation of geophysical logs, synthetic seismograms, calculating effective porosities and saturations. However, the requirement of converting recorded digital data to be compatible with the input of different digital computers and to all the various formats for individual programs is a problem that will require standardization in formats. It is evident that the advantages to be realized in data reduction processes will require the log of the future to be recorded in digital as well as analog form.--Auth.

3-197. "GAS EXPLODER" SURVEY GOES COMMERCIAL: *Petroleum Week*, v. 10, no. 24, p. 46, 48, June 17, 1960.

The "gas exploder" type of continuous seismic profiling device can now be used for commercial exploration surveys of strata more than 4,000 ft. below the ocean floor. The instrument used by Marine Geophysical Services Corp. of Houston has been in service off the U.S. West and Gulf coasts, off the coasts of Peru, England, and Thailand, and in the Gulf of Paria and Lake Maracaibo. The seismic source is the explosion of a mixture of propane and oxygen, utilizing 3 exploder chambers towed below the water in individual "fish" and fired simultaneously. The "echoes" are received by a hydrophone array, consisting of several detector elements spaced along the detector cable. The explosion chambers are virtually unaffected by wave and swell action, so surveys can be conducted in almost all sea conditions, from moderate to rough. Various types of craft can be used successfully for the surveys, including cabin cruisers for inland waters, and, for hard-to-reach inland lakes, even a float-equipped airplane.--C. C. McFall.

3-198. Ewing, John, and others. **SUB-BOTTOM REFLECTION MEASUREMENTS ON THE CONTINENTAL SHELF, BERMUDA BANKS, WEST INDIES ARC, AND IN THE WEST ATLANTIC BASINS:** *Jour. Geophys. Research*, v. 65, no. 9, p. 2849-2859, 12 figs. incl. map, secs., diags., profiles, Sept. 1960, 11 refs.

During a recent cruise of *R. V. Vema*, a short survey was made with the sub-bottom depth recorder in the vicinity of the Hudson canyon between the 40-fathom and the 400-fathom contours. The results show that on this part of the continental shelf the upper layers are approximately horizontal, whereas the deeper ones dip seaward at a slightly greater angle than the bottom. Several reflecting horizons

were observed at depths as great as 400 ft. below the bottom, and many were traced for distances of the order of 10 to 20 mi. Where the canyon cuts through the sediments of the shelf, several of the sub-bottom horizons outcrop on the canyon walls, sometimes correlating with benches or knees. Some of the horizons at the outcrops are practically horizontal, in particular those on the NE. wall; others, notably the deep ones on the SW. wall, are sloping, tending to follow the contour of the canyon wall. Sediment cores were taken in a few locations, providing some information about the reflecting horizons (reflectors).

On Challenger bank and on Plantagenet bank near Bermuda, no sub-bottom reflectors were found. On the West Indies arc near Puerto Rico and the Virgin Islands, shallow reflectors were seen in some areas.

During a run from New York to Bermuda to Puerto Rico, sub-bottom reflectors were seen on the echosounder fathogram at least 40% of the time. The best results were obtained on the topographic rises, particularly on the outer rise N. of the Puerto Rico trench.--Auth.

3-199. Press, Frank, and others. **A LUNAR SEISMIC EXPERIMENT:** *Jour. Geophys. Research*, v. 65, no. 10, p. 3097-3105, 5 figs. incl. 3 graphs, 3 tables, Oct. 1960, 12 refs.

A feasibility study shows that a lunar seismic experiment can provide significant data on the structure and composition of the moon. The presence or absence of lunar seismicity is an important clue to current tectonic processes that affect the lunar surface. In the first generation of experiments, single detectors are envisaged with the capability of recording body and surface waves. Investigation of proposed methods of lunar-seismogram interpretations indicates that these detectors should be sufficient to give a rough outline of lunar seismic geography and to indicate crudely the composition of the moon as well as its main structural features. In the absence of lunar seismicity, the best statistics on the frequency of meteorite impacts indicate that meteorites may provide useful auxiliary seismic sources. In reaching this conclusion, reasonable estimates were made of the efficiency of impact as well as of seismic-wave attenuation. Critical factors in the experiment are instrument lifetime and sensitivity and the nature of lunar microseismic noise.--Auth.

3-200. Broecker, Wallace S., and others. **NATURAL RADIOCARBON IN THE ATLANTIC OCEAN:** *Jour. Geophys. Research*, v. 65, no. 9, p. 2903-2931, 9 figs. incl. 2 charts, diags., graphs, 9 tables, Sept. 1960, 44 refs.

By the use of suitable chemical and radiometric techniques the natural radiocarbon concentration in the dissolved bicarbonate of 135 samples representing the major water masses of the Atlantic Ocean has been determined with a precision ranging from 0.5 to 1.3%. Whereas the results from a given water mass exhibit a standard deviation only slightly exceeding that predicted from the experimental error alone, measurable differences exist between the major water masses, the total range in C^{14}/C^{12} ratio being about 10%. Corrections for the bomb-produced C^{14} effect and the industrial CO_2 effect have been applied where necessary.

The surface water C^{14}/C^{12} ratios show a progressive increase from S. to N., ranging from 120

per mil lower than the preindustrial atmospheric value in the Antarctic to 50 per mil lower in the North Atlantic. Deep water masses originating in the high latitudes of the southern hemisphere have consistently lower C^{14}/C^{12} ratios than those originating in the high latitudes of the northern hemisphere. A layer of water of high C^{14}/C^{12} ratio found at depths between 1,200 and 2,400 m. in the western North Atlantic may well represent a wedge of young water penetrating the older North Atlantic deep water. Bottom water in the eastern basin of the North Atlantic has a 20 per mil lower C^{14}/C^{12} ratio than the corresponding water in the western basin.

According to a steady-state circulation model, most of the water below 600 m. in the North Atlantic remains at depth for an average of 650 years. Corresponding residence times for water masses of Antarctic origin are less than 350 years.

A circulation model explaining the prominent features of the C^{14} distributions in the atmosphere-ocean system is based on a S. to N. transport of water along the surface of the Atlantic Ocean, with a return flow at depth. The Atlantic and Pacific communicate through the Antarctic. On the basis of this model, despite the lower $4C^{14}$ values, the mean residence times of water in the deep reservoirs of the Pacific may not exceed those for the deep Atlantic by more than 30%.

Although results of C^{14} analyses on tree rings suggest that the oceans are reasonably close to steady state, the possibility of nonsteady-state circulation must be considered. It is shown that the present C^{14} distribution in the oceans could be achieved through the storage of C^{14} in the atmosphere and surface oceans during a relatively short period of greatly restricted bottom water formation. If nonequilibrium effects are important the residence times computed from the steady-state model could be considerably in error.--Auth.

3-201. Batzel, Roger E. RADIOACTIVITY ASSOCIATED WITH UNDERGROUND NUCLEAR EXPLOSIONS: Jour. Geophys. Research, v. 65, no. 9, p. 2897-2902, graph, 4 tables, Sept. 1960, 10 refs.

The detonation of a contained or partially contained nuclear explosion is accompanied by the deposition of a large fraction of the energy in the form of high-temperature, high-pressure regions. The nature of the surrounding medium, the time-temperature history, and the time of cavity collapse or venting determine the extent to which undesirable nuclides such as Sr^{90} and Cs^{137} will appear outside a fused, relatively insoluble matrix and be available to ground water or to the atmosphere. The movement of these undesirable radioactive nuclides relative to the ground-water movement can be predicted on the basis of measured K_p 's (distribution coefficients) for the radioactivities in the medium.

The induced radioactivities are a 20 to 25% contribution to the fission product radioactivity for times of the order of 1 day, and a 1% contribution for times equal to about 1 week. The contribution decreases to 0.1% after about 45 days, but later, because of the Co^{60} present, it increases to about 2% for a period of 3 to 15 years.--Auth.

3-202. Mero, John L. USES OF THE GAMMA-RAY SPECTROMETER IN MINERAL EXPLORATION: Geophysics, v. 25, no. 5, p. 1054-1076, 14 graphs, 6 tables, Oct. 1960, 15 refs.

Gamma-ray spectroscopy offers a rapid and reli-

able radiometric method of analysis of U and/or Th ores. Methods of ore analysis are described, and experimental results are presented. The U-Th ratios of rocks, which are important in strata recognition and correlation studies, can be determined directly by gamma-ray spectroscopy without the necessity of making individual U or Th assays.

Analysis of potash ores is facilitated with a gamma-ray spectrometer. Erratic behavior of gamma-ray well logs can often be resolved by studying the gamma-ray spectra of these logs. Neutron-activation, followed by gamma-ray spectral analysis, of common earth materials offers a method of borehole rock analysis for elements such as Ca, H, Cl, S, and Mg. Data in studies employing radioactive tracers can often be enhanced through use of a gamma-ray spectrometer. Other present and potential applications of the gamma-ray spectrometer in mineral exploration are also discussed.--Auth.

3-203. Mardock, Edwin S. RADIOACTIVITY LOGGING AND ITS FUTURE POTENTIAL: Geophysics, v. 25, no. 4, p. 883-890, Aug. 1960, 29 refs.

The quantitative application of radioactivity logs for the estimation of formation petrophysical properties is dependent on certain fundamental factors which are discussed. It is difficult to avoid "hybrid" combinations of processes; for example neutron-neutron and neutron-gamma effects together; however, it is believed that the future of quantitative application of neutron logs depends to a large extent on the development of single component logging processes. Positive location of the sonde within the borehole for all types of logs needs further development. These improvements plus future developments in gamma-ray spectral logs, neutron-gamma spectral logs, neutron activation logs, and neutron inelastic scattering logs promise a bright future for radioactivity logging.--Auth.

3-204. Pickell, J.J. and J.G. Heacock. DENSITY LOGGING: Geophysics, v. 25, no. 4, p. 891-904, 9 figs. incl. diags., graphs, logs, table, Aug. 1960, 5 refs.

This review of density logging is primarily a compilation of information presented in the petroleum industry literature. It includes a brief discussion of some of the theory involved in gamma-ray density logging, various calibration curves, comparisons of density-log and core data, and comments on density-log interpretation.

Conclusions are that the density log, under good borehole conditions, provides an accurate means for measuring bulk density of the formation adjacent to the borehole. If grain density is known, valid estimates of porosity can also be made.

Because of the response characteristics of the system, accuracy in determining porosity is best when formation densities are low and porosities are high.--Auth.

3-205. Woodside, W., and J.H. Messmer. MOLECULAR EFFECTS IN HEAT CONDUCTION THROUGH POROUS ROCKS: Jour. Geophys. Research, v. 65, no. 10, p. 3481-3485, 3 graphs, Oct. 1960, 9 refs.

Thermal conductivity measurements were made on a natural Berea sandstone sample of porosity 22%, with the pore space filled with various fluids at atmospheric pressure. The results indicate that the

effective conductivity of the sample, when filled with a gaseous saturant, is lower than when filled with a liquid saturant of the same conductivity as the gas. This effect is qualitatively accounted for by the reduction in thermal conductivity of the gas which occurs when the gas occupies spaces which are small

relative to its mean free path. The presence of such spaces is confirmed by pore size distribution data and by the increase in effective conductivity with increase in gas pressure. The effect on the thermal conductivity of a simulated net overburden pressure of 275 bars was also investigated.--Auth.

7. GEOCHEMISTRY

See also: Igneous and Metamorphic Petrology 3-258; Geohydrology 3-281, 2-282; Mineral Deposits 3-287; Fuels 3-301 through 3-308.

3-206. Hoffmann, R. W., and George W. Brindley. ADSORPTION OF NON-IONIC ALIPHATIC MOLECULES FROM AQUEOUS SOLUTIONS ON MONTMORILLONITE. CLAY - ORGANIC STUDIES - II: *Geochim. et Cosmochim. Acta*, v. 20, no. 1, p. 15-29, 3 diags., 2 tables, Sept. 1960, 22 refs.

A series of nonionic aliphatic compounds was adsorbed from aqueous solutions on Ca-montmorillonite, and the adsorption isotherms were determined. The differences in molar adsorption are attributed to the influence of the chain length and the CH-activity. These effects are shown to operate independently.

The (001) spacings of the clay-organic complexes were measured and 1-, 2-, and 3-layer complexes were recorded. The orientation of the molecules in the 1-layer complexes is discussed. It is considered that aliphatic molecules orient with the plane of their chain both parallel and perpendicular to the clay surface.--Auth.

3-207. Listova, L. P. THE PRECIPITATION OF RHODOCHROSITE FROM SOLUTIONS OF MANGANESE CHLORIDE, SULFATE AND BICARBONATE: *Akad. Nauk SSSR, Doklady, Earth Sci. Secs.*, in English translation, v. 124, no. 1-6, p. 4-8, illus., graph, 4 tables, Jan.-Feb. 1959, pub. Apr. 1960, 2 refs.

The precipitation of rhodochrosite from chloride, sulfate, and bicarbonate solutions was studied as a function of concentration, CO_2 pressure and pH. Eh was also determined in the experimental solutions. It was found that at high Mn^{++} concentrations precipitation could take place at pH values as low as 5.5. At pH 8.5-8.8 precipitation from solutions at all concentrations could be regarded as complete. In acid or neutral media rhodochrosite is not oxidized by gaseous O, but at pH greater than 8.5 undissociated $\text{Mn}(\text{OH})_2$ may form, which begins to oxidize in the presence of even traces of O.

Attempts to determine the system $\text{MnO}-\text{CO}_2-\text{H}_2\text{O}$ by dissolving rhodochrosite in water containing free CO_2 in various amounts did not prove successful due to the great resistance of native rhodochrosite to solution. In this respect rhodochrosite is similar to native magnesium and iron carbonates.--F. Manheim.

3-208. Olshansky, Ya. I., and others. THE SOLUBILITY OF SILVER SULFIDE IN AQUEOUS SOLUTIONS SATURATED WITH HYDROGEN SULFIDE: *Akad. Nauk SSSR, Doklady, Earth Sci. Secs.*, in English translation, v. 124, no. 1-6, p. 9-12, diag., 3 graphs, table, Jan.-Feb. 1959, pub. Apr. 1960, 3 refs.

The solubility of silver sulfide has been investi-

gated at various pH values and temperatures from 25 to 160°C. by means of radioactive Ag^{110} as a tracer.

Marked increases in solubility with increasing pH and temperature were observed and a decrease in the concentration of Ag was noted when saturated solutions were aged.

The authors confirm the conclusion of Treadwell and Hepenstrik that the solubility of Ag_2S in solutions containing H_2S is due to the formation of complexes of the type AgHS and AgS^- . They further conclude that at temperatures of a few hundred degrees the solubility of Ag_2S may be as much as several mg./l., high enough to allow the formation of hydrothermal argentite by crystallization from aqueous solution.--F. Manheim.

3-209. Pommer, Alfred M., and Irving A. Breger. POTENTIOMETRIC TITRATION AND EQUIVALENT WEIGHT OF HUMIC ACID: *Geochim. et Cosmochim. Acta*, v. 20, no. 1, p. 30-44, 5 diags., 2 tables, Sept. 1960, 21 refs.

The "acid nature" of humic acid has been controversial for many years. Some investigators claim that humic acid is a true weak acid, while others feel that its behavior during potentiometric titration can be accounted for by colloidal adsorption of H ions. The acid character of humic acid has been reinvestigated using newly-derived relationships for the titration of weak acids with strong base. Re-interpreting the potentiometric titration data published by Thiele and Kettner in 1953, it was found that Merck humic acid behaves as a weak polyelectrolytic acid having an equivalent weight of 150, a pK_a of 6.8 to 7.0, and a titration exponent of about 4.8. Interpretation of similar data pertaining to the titration of phenol-formaldehyde and pyrogallol-formaldehyde resins, considered to be analogs for humic acid by Thiele and Kettner, leads to the conclusion that it is not possible to differentiate between adsorption and acid-base reaction for these substances.--Atruh.

3-210. Pommer, Alfred M., and Irving A. Breger. EQUIVALENT WEIGHT OF HUMIC ACID FROM PEAT: *Geochim. et Cosmochim. Acta*, v. 20, no. 1, p. 45-50, 2 diags., Sept. 1960, 9 refs.

By means of discontinuous titration, the equivalent weight of humic acid isolated from a peat was found to increase from 144 to 183 between the third and fifty-second day after the humic acid was dissolved. Infra-red studies showed that the material had probably condensed with loss of carbonyl groups.--Auth.

3-211. Harris, P. G., and J. A. Rowell. SOME GEOCHEMICAL ASPECTS OF THE MOHOROVICIC DISCONTINUITY: *Jour. Geophys. Research*, v. 65, no. 8, p. 2443-2459, graph, 2 tables, Aug. 1960, 67 refs.

Hypotheses of mantle composition and of the nature

of the Mohorovičić discontinuity are discussed.

It is considered a) that there is no evidence for the assumption that meteorite compositions can be applied in their entirety to the composition of the earth; b) that even assuming the earth to have a chondritic composition does not permit any calculation of the composition of earth layers; and c) that any analogy between achondrites and the earth cannot be applied quantitatively and is of no relevance to problems of the Mohorovičić discontinuity.

Geological evidence indicates that the upper mantle is of peridotitic composition. Though conditions for eclogite stability do exist within the earth, there is no evidence for the hypothesis that the Mohorovičić discontinuity coincides with a phase transformation to eclogite.--Auth.

3-212. Mason, Brian. THE ORIGIN OF METEORITES: Jour. Geophys. Research, v. 65, no. 9, p. 2965-2970, diag., graph, Sept. 1960, 14 refs.

Current hypotheses generally interpret chondritic meteorites as being debris from a disrupted planet. It is suggested that these meteorites are not fragments of such a body, but have always been independent and individual objects. They can have been produced by the recrystallization of material now represented by the carbonaceous chondrites. The composition of carbonaceous chondrites is such that if they are heated above 600°C. they would give a mixture of olivine, orthopyroxene, and Ni-Fe similar to that of the chondritic meteorites. The friable and porous nature and the chondritic structure of these objects suggest recrystallization essentially in the solid state, as does the intimate admixture of Ni-Fe and silicate. The other types of meteorites - achondrites, pallasites, and siderites - can be explained as fragments of a differentiated planetoid or planetoids formed by the aggregation of chondrites.--Auth.

3-213. Fireman, E. L., and J. DeFelice. ARGON 37, ARGON 39, AND TRITIUM IN METEORITES AND THE SPATIAL CONSTANCY OF COSMIC RAYS: Jour. Geophys. Research, v. 65, no. 10, p. 3035-3041, 3 figs. incl. diags., table, Oct. 1960, 5 refs.

The radioactive isotopes Ar 37, Ar 39, and tritium are measured in the Hamlet chondritic meteorite and in the Aroos Fe meteorite. The ratio of the radioactivity of Ar 37 to that of Ar 39 at the time of fall is 2.3 ± 0.2 for the Hamlet meteorite and 1.4 ± 0.3 for the Aroos meteorite. The ratio of the production rate of Ar 37 to that of Ar 39 in a sample of the Hamlet meteorite irradiated with 2-bev. protons is 1.2 ± 0.3 . These measurements indicate a higher flux of cosmic rays at a distance of 1 astronomical unit from the sun than at several astronomical units. The ratio of the radioactivity of tritium to that of Ar 39 is 29 ± 6 for the Hamlet meteorite and 2.0 ± 0.5 for the Aroos meteorite. The ratio of the production rates in the Hamlet target sample is 24 ± 6 . The ratio of tritium to that of Ar 39 in the Benton chondritic meteorite is 29 ± 4 . The data indicate that the cosmic-ray flux integrated over the same region of space for different times is constant. The tritium is anomalously low in the Aroos Fe meteorite. Similar tritium anomalies have been observed previously in Fe meteorites.--Auth.

3-214. Anders, Edward, and C. M. Stevens. SEARCH FOR EXTINCT LEAD 205 IN METEORITES: Jour. Geophys. Research, v. 65, no. 10, p. 3043-3047, 3 tables, Oct. 1960, 21 refs.

The isotopic composition of Tl from 6 meteorites was measured, in order to determine whether any radiogenic Tl^{205} from the decay of 24-m. y. Pb^{205} was present. Although the Pb/Tl ratios of these meteorites differed by factors of 50, isotopic compositions of meteoritic and terrestrial Tl were equal to within 1%. For Canyon Diablo, this implies a solidification time of $\geq 3.0 \times 10^8$ years after nucleogenesis by the "sudden synthesis" model, and $> 1.0 \times 10^8$ years after the isolation of the solar system by the "continuous synthesis" model. The bearing of these results on the ^{129}Xe - ^{129}Xe ages of Reynolds is discussed.--Auth.

3-215. DuFresne, Ann. SELENIUM AND TELLURIUM IN METEORITES: Geochim. et Cosmochim. Acta, v. 20, no. 2, p. 141-148, 5 tables, Oct. 1960, 5 refs.

It is evident that the more reliable Se data vary considerably from 13.7 p.p.m. to 4.8 p.p.m. for the observed falls and from 2.92 p.p.m. to 0.92 p.p.m. for the finds. The lower values for the finds is difficult to understand, but in the absence of analytical data of the major constituents such as S it is impossible to judge whether weathering may be responsible for the low values. A variation by a factor of 3 in the Se abundances and by a factor of more than 10 in the Te abundances for the falls show that considerable fractionation of these elements has occurred, and hence we can have little confidence that the observed amounts represent the true primitive abundances. The concentrations of Se and Te abundances do not follow each other nor the S analyses in any regular way except that the highest amounts of all 3 elements occur in Indarch, which is a carbonaceous chondrite. It is evident that some fractionation process has separated these chemically similar elements. In view of such marked effects, it is not possible to regard the chondritic meteorites as reliable samples of the primitive elementary abundances of these elements and probably of other elements as well.--Auth. discussion.

3-216. Reed, George W., and others. DETERMINATIONS OF CONCENTRATIONS OF HEAVY ELEMENTS IN METEORITES BY ACTIVATION ANALYSIS: Geochim. et Cosmochim. Acta, v. 20, no. 2, p. 122-140, 2 diags., 6 tables, Oct. 1960, 31 refs.

Ba, Hg, Tl, Pb, Bi, and U contents and isotopic composition of stone and the troilite phase of Fe meteorites have been determined by neutron activation analysis. Two groups of chondrites were observed; the one containing enstatite and carbonaceous chondrites has orders of magnitude more of the chalcophilic elements studied than other chondrites. Ba and U do not show this variation. The Pb in this group is primordial in its 208/204 isotopic composition as might be expected from the Pb/U ratio. Some of the nuclear and geochemical implications of the results are suggested.--Auth.

3-217. Goles, G. G., and others. THE RECORD IN THE METEORITES - I. THE FORMER ENVIRONMENT OF STONE METEORITES AS DEDUCED FROM K^{40} - Ar^{40} AGES: Geochim. et Cosmochim. Acta, v. 19, no. 3, p. 177-195, 5 diags., 2 tables, July 1960, 52 refs.

The K-Ar ages of meteorites are systematically lower than the Rb-Sr and Pb-Pb ages, owing to diffu-

sion losses of Ar. An equation is derived that gives the apparent K-Ar age as a function of the "true" age and the parameter D/a^2 , the diffusion constant of Ar^{40} divided by the square of the radius of the K-bearing grains. The dependence of D/a^2 in stone meteorites on temperature may be obtained from the work of Geiss and Hess, so that given a "true" and an apparent age, it is possible to deduce an upper limit to the mean temperature at which a meteorite was held since the cessation of strong heating in its parent body. The activation energy for the diffusion of radiogenic Ar^{40} from meteorites is unexpectedly small (14 kcal./mole), so that for a group of 8 dated chondrites, the upper limit to the mean environmental temperature is found to be $\leq 196^\circ K$. This low value implies that the parent body of the chondrites was no closer to the sun than 1.44 astronomical units (a.u.), and no larger than 250 km. in radius, for radiation temperatures are higher near the sun, and long-lived radioactivities produce higher temperatures in bodies as large as 300 km. in radius. The compatibility of these limits with current theories on the origin of meteorites is examined, and some crucial experiments are proposed.

Further diffusion losses will occur after the release of the meteorites from their parent bodies. Consideration of the radiation temperature of a meteorite in space shows that even for perihelia barely within the earth's orbit, some 10-20% of the radiogenic and cosmic-ray induced Ar will be lost in times the order of typical exposure ages of chondrites.--Auth.

3-218. Lovering, John F., and others. TEMPERATURES AND MASS LOSSES IN IRON METEORITES DURING ABLATION IN THE EARTH'S ATMOSPHERE: *Geochim. et Cosmochim. Acta*, v. 19, no. 3, p. 156-167, 3 illus., 2 diags., table, July 1960, 20 refs.

The results of thermomagnetic analyses of 2 Ni-rich ataxites (Tawallah Valley and Wedderburn) have been used to estimate the temperature gradients within their thermal alteration rims which formed during flight through the earth's atmosphere. Knowing these temperature gradients it is possible to calculate temperature rises within Fe meteorites during ablation as well as the average rate of ablation of the surfaces of these meteorites (i.e. about 0.18 cm./sec.). If the time during which ablation takes place averages 3.3 sec., then the average thickness of material ablated from the surfaces of these Fe meteorites is about 0.6 cm. These data indicate that about 27% of the pre-atmospheric mass of the Tawallah Valley ataxite and about 60% of the smaller Wedderburn ataxite has been ablated in the atmosphere.--Auth.

3-219. Stoenner, R. W., and others. METEORITES AS SPACE PROBES FOR TESTING THE SPATIAL CONSTANCY OF COSMIC RADIATION: *Jour. Geophys. Research*, v. 65, no. 10, p. 3025-3034, 5 figs. incl. 3 diags., 3 tables, Oct. 1960, 14 refs.

An experiment has been performed to test the spatial constancy of cosmic radiation within the solar system by measuring a short-lived and long-lived cosmic-ray-induced radioactivity in a recently fallen stone meteorite. The measurement was performed on the Hamlet chondrite that fell in Indiana on October 13, 1959. The ratio of the 35-day Ar 37 to the 325-year Ar 39 was found to be 2.0 ± 0.3 . The relative production rates for these isotopes was determined by bombarding the meteorite with 3-bev. pro-

tons. The ratio of the Ar 37 to Ar 39 production rates was found to be 1.5 ± 0.2 . Since the ratios were the same within experimental uncertainty, it was concluded that the flux of cosmic radiation is constant in the space between the earth and the asteroidal belt. The Ar 39 contents of 4 other chondrites were measured. The values obtained were as follows: Rich-ardton 7.1 ± 0.6 , Murray 9.4 ± 0.5 , Forest City 11.9 ± 0.5 , Benton 9.0 ± 0.4 , and Hamlet 7.8 ± 0.2 dis./min. kg.--Auth.

3-220. Van Dilla, Marvin A., and others. SPECTROMETRIC MEASUREMENT OF NATURAL AND COSMIC-RAY INDUCED RADIOACTIVITY IN METEORITES: *Geochim. et Cosmochim. Acta*, v. 20, no. 2, p. 115-121, 4 diags., Oct. 1960, 14 refs.

A nondestructive method of analysis of meteorites for natural and cosmic-ray induced radioactivity using low-level γ -ray spectrometry of kilogram samples is reported. Results so far obtained are essentially qualitative but appear to be in agreement with previous chemical measurements of K and Al^{26} in chondrites and achondrites. Cobalt⁶⁰ was detected in the Ussuri (Sikhote-Alin) siderite (fell 1947) but not in old falls such as Odessa and Canyon Diablo. The rate of production of some interesting cosmic-ray induced activities is discussed.--Auth.

3-221. Signer, P., and Alfred O. Nier. THE DISTRIBUTION OF COSMIC-RAY-PRODUCED RARE GASES IN IRON METEORITES: *Jour. Geophys. Research*, v. 65, no. 9, p. 2947-2964, 12 figs. incl. diags., graphs, 4 tables, Sept. 1960, 22 refs.

The cosmogenic Ar^{38} , Ar^{36} , Ne^{22} , Ne^{21} , Ne^{20} , He^4 , and He^3 distribution in part of a cross section of the Fe meteorite Grant has been measured. The amounts were found to vary systematically with depth. The depth effect was analyzed in terms of a production mechanism, and numerical parameters were determined. Comparisons were made with the results of other investigations. Functional relationships correlating relative amounts of cosmogenic nuclides with position and size of a meteoritic body are demonstrated. In principle the determination of a sufficient number of cosmogenic nuclides in a single sample permits deductions about the radiation dosage and the size of the meteoroid as well as the location of the sample within the body.--Auth.

3-222. Fisher, D. E., and Oliver A. Schaeffer. COSMOGENIC NUCLEAR REACTIONS IN IRON METEORITES: *Geochim. et Cosmochim. Acta*, v. 20, no. 1, p. 5-14, 5 tables, Sept. 1960, 29 refs.

The cosmogenic He^3 , He^4 , Ne^{21} , Ne^{22} , Ar^{36} , and Ar^{38} isotopes have been measured mass spectrometrically in 7 ataxites and one octahedrite. An attempt at analysis of these and previous data is made based on nuclear reactions induced by high-energy protons. A combination of He^3/He^4 , He^3/Ar^{38} , and Ne^{21}/Ar^{38} ratios are used as a measure of the energy and intensity of the incident radiation. Factors contributing to anomalous ratios are discussed. Exposure ages are deduced on the basis of these ratios, total isotopic abundances, and previously measured Cl^{36} values.--Auth.

3-223. Singer, S. Fred. PRODUCTION OF TRITIUM IN NUCLEAR SPALLATIONS: *Geochim. et Cosmochim. Acta*, v. 19, no. 3, p. 216-217, July

1960, 11 refs.

Production cross-sections for tritium have been measured in cyclotron targets and have been quoted as 53, 62, and 130 millibarns. These are compared with values deduced from cosmic-ray bombardment of Fe meteorites, where a direct tritium measurement leads to 280 mb., while He^3/He^4 ratio measurements lead to at least 215 mb., possibly as high as 410 mb. Hence application of cyclotron cross-sections may lead to too high values for the cosmic-ray ages of meteorites.--Auth.

3-224. DIAMONDS MAY BE FORMED AS METEORITES HIT EARTH: *Sci. News Letter*, v. 78, no. 18, p. 277, Oct. 29, 1960.

At least 4 meteorites have been found to contain diamonds. To postulate that the diamonds were present in the meteorite before entering the earth's atmosphere would require the parent body of the meteorite to have been at least as large as the moon. Sufficient pressure and temperature to form diamonds on impact could be expected if the meteorite is at least 100 tons and hits the ground with a velocity of between 10 and 15 mi. per sec.--M. Russell.

3-225. Ringwood, A.E. THE NOVO UREI METEORITE: *Geochim. et Cosmochim. Acta*, v. 20, no. 1, p. 1-4, illus., table, Sept. 1960, 8 refs.

The occurrence of diamond in Nova Urei has been confirmed by X-ray diffraction. Chemical and mineralogical studies of this meteorite suggest that it is an intensely metamorphosed chondrite.--Auth.

3-226. Crozier, William D. BLACK, MAGNETIC SPHERULES IN SEDIMENTS: *Jour. Geophys. Research*, v. 65, no. 9, p. 2971-2977, 2 graphs, 3 tables, Sept. 1960, 12 refs.

Specimens of sedimentary materials from formations distributed over the sequence from Recent to Ordovician have been processed for recovery of magnetic particles. Magnetic particles were found in all specimens, and among them were black spherules in numbers ranging from 28 to 240 per gram of sediment. These are apparently identical to and have the same size distribution as the black, magnetic spherules currently being collected from the atmosphere and to the magnetic spherules of supposed meteoritic origin that for many years have been reported in deep sea sediments.

Two specimens of deep sea sediment were among those studied. They were found to contain larger spherules in numbers of the same order as those reported by Laevastu and Mellis, but spherules smaller than 40μ in diameter were much more abundant. A large and, thus far, unresolved discrepancy appears to exist between the annual infall of spherules calculated for the deep sea sediments and that calculated for the San Agustin playa deposits and for the present atmospheric deposit.--Auth.

3-227. Ehmann, W.D. NICKEL IN TEKTITES BY ACTIVATION ANALYSIS: *Geochim. et Cosmochim. Acta*, v. 19, no. 3, p. 149-155, table, July 1960, 18 refs.

The Ni abundances of most of the major occurrences of tektites, as well as several meteorite impact glasses and obsidians, have been determined using neutron activation analysis. Fe abundances

have been determined in the same specimens and Ni/Fe abundance ratios tabulated. These ratios, determined for the first time on the Libyan Desert glass, the Ivory Coast tektites, and the bediasites, indicate all these specimens fall within the known range of this ratio for the other tektite occurrences. On the basis of this ratio, major differences are observed among specimens from the indochinite tektite occurrence, but no significant differences are observed among specimens from 3 separate philippinite sites. The differences in the Ni/Fe ratios for tektites and known meteorite impact glasses suggest different modes of formation.--Auth.

3-228. Reynolds, John H. RARE GASES IN TEKTITES: *Geochim. et Cosmochim. Acta*, v. 20, no. 2, p. 101-114, 4 diags., 3 tables, Oct. 1960, 17 refs.

Tektites from a number of localities have been examined for their contents of K, atmospheric Ar, radiogenic Ar, atmospheric Ne, and possible cosmogenic Ne. At 300°K , the coefficient of diffusion for He in tektite glass from Kalgoorlie, Australia, is $4 \times 10^{-10} \text{ cm}^2/\text{sec}$. The activation energy for He diffusion is 0.27 electron volts. The He solubility constant is 0.005. Corresponding quantities for Ne diffusion are $2 \times 10^{-15} \text{ cm}^2/\text{sec}$, .061 electron volts and 0.005. The He diffusion rate is so high that tektites retain no radiogenic or cosmogenic He. The recent group of tektites, however, should retain a substantial amount of any cosmogenic Ne contained at time of fall. In no case was any excess Ne^{21} detected. From the upper limits of original Ne^{21} content, a maximum "flight time" since last melting has been computed for each tektite. For a tektite from Kalgoorlie, this is 28,000 years. This result is in apparent disagreement with the finding by Ehmann and Kohman of radioactive Al^{26} in australites. K-Ar ages have been computed for each tektite. These range from 0 to 32 million years and are usually in agreement with the stratigraphic age of the formations on which the tektites lie, according to presently accepted time scales. Data in this paper do not support a recent suggestion that the moldavites of Czechoslovakia and the recently discovered tektites from Georgia, U.S.A. are part of the same fall.--Auth.

3-229. Taylor, S.R. ABUNDANCE AND DISTRIBUTION OF ALKALI ELEMENTS IN AUSTRALITES: *Geochim. et Cosmochim. Acta*, v. 20, no. 2, p. 85-100, map, 4 diags., 9 tables, Oct. 1960, 35 refs.

Na and K have been determined by flame photometric methods, and Li, Rb, and Cs by emission spectrographic techniques in 14 australites from Western Australia, South Australia, and the Northern Territory. Arithmetic means of the analytical data are: Li, 42 p.p.m.; Na, 0.95%; K, 1.89%; Rb, 84 p.p.m.; Cs, 2.7 p.p.m. These figures are of the same order of magnitude as terrestrial abundances and match the abundances in sedimentary rocks somewhat better than those for igneous rocks. The averages for Na and K are virtually identical to those found by Pinson and Schetzler for 11 philippinites and indochinites. The dispersion in concentration of the alkali elements is much smaller than in specific terrestrial rock types such as granites, but is distinctly greater than the small dispersion found in chondrites. It is a significant variation, being greater than the limits of analytical precision for the

individual elements.

All the elements show a close association with one another. Coefficients of correlation (r) range from +0.730 for the pair Li-Rb to +0.962 for the pair Na-K, and the degree of correlation is statistically "highly significant." It is concluded that such a coherence arises from a physical process such as mixing, rather than by chemical means.

A regional variation in composition, with higher concentrations of alkali elements towards the W. of Australia, is observed.--Auth.

3-230. Heinrich, E. Wm., and others. RELATIONSHIPS BETWEEN GEOLOGY AND COMPOSITION OF SOME PEGMATITIC MONAZITES: *Geochim. et Cosmochim. Acta*, v. 19, no. 3, p. 222-231, graph, 3 tables, July 1960, 16 refs.

Fourteen monazites from several well-studied pegmatites and pegmatite districts in the western United States have been analysed by X-ray fluorescence spectrometry for the Ce subgroup of rare-earth elements, as well as Y and Th. The results have been correlated with the paragenesis, mineralogy, and geology of the occurrences. They show several distinct, and in some cases unique, rare-earth element distributions which are characteristic not only of individual pegmatites but also of entire pegmatite districts.--Auth.

3-231. Fornaseri, M., and L. Grandi. FLAME PHOTOMETRIC DETERMINATION OF STRONTIUM IN SILICATES. STRONTIUM CONTENT OF THE GRANITE G-1 AND THE DIABASE W-1: *Geochim. et Cosmochim. Acta*, v. 19, no. 3, p. 218-221, 2 tables, July 1960, 8 refs.

A method for the determination of Sr in silicate materials by flame photometry is described, based on the standard addition technique. It takes background emission measurements into account, and, where necessary, high concentrations of Ca salts are added to compensate for the depressing effect of Al.

With this method, a Sr content of 258 p.p.m. in granite G-1 and of 151 p.p.m. in diabase W-1 was found. Precision and accuracy of the method are discussed.--Auth.

3-232. Taylor, S. R. OCCURRENCE OF ALKALI METALS IN SOME GULF OF MEXICO SEDIMENTS: AMENDED RUBIDIUM VALUES AND K/Rb RATIOS: *Jour. Sed. Petrology*, v. 30, no. 2, p. 317-321, diag., 2 tables, June 1960, 18 refs.

The Rb values for sediments described by C. W. Welby are recalculated to conform to the recommended (Ahrens and Fleischer, *GeoScience Abstracts* 2-2378) new Rb values for a standard granite (G-1) and a standard diabase (W-1). A plot of the original and amended Rb values versus K is given.--D. Carroll.

3-233. Nikonov, V. F. AUTHIGENIC IRON, SULFUR, ORGANIC CARBON, AND BITUMENS IN THE MESOZOIC SEDIMENTS OF THE EASTERN PRI-URAL REGION: *Akad. Nauk SSSR, Doklady, Earth Sci. Secs.*, in English translation, v. 124, no. 1-6, p. 48-50, map, chart, Jan.-Feb. 1959, pub. Apr. 1960, 12 refs.

In the sediments investigated the concentration of

organic C and bitumens is highest in rocks low in Fe. S and bitumens generally have a reciprocal relationship, but exceptions are noted. The bitumen content and degree of reduction, as given by the Fe^{2+}/Fe^{3+} ratio both increase consistently with increasing age from Oligocene to Upper Jurassic sediments. There is no observable relationship between the degree of reduction and the organic content.

S is given a key role in the origin of the above relationships. It is believed to first accumulate in the sediments as the sulfate ion, but later oxidizes organic matter in the course of diagenesis with accompanying formation of sulfides.--F. Manheim.

3-234. Jurain, G. MOYENS ET RÉSULTATS D'ÉTUDE DE LA RADIOACTIVITÉ [SIC] DUE AU RADON DANS LES EAUX NATURELLES (Means and Results of Study of Radioactivity due to Radon in Natural Waters): *Geochim. et Cosmochim. Acta*, v. 20, no. 1, p. 51-82, illus., 5 maps, 12 diags., 11 tables, Sept. 1960, 28 refs.; text in French, abs. in English.

A field method for the determination of the Rn content of natural waters is described, and the results obtained in the course of 2 surveys in different regions of France have been analyzed using statistical methods. It appears that: 1) the Rn contents are distributed lognormally in a given geological formation; 2) the determination of Rn in waters is capable of development into a geochemical prospecting technique; 3) the Rn contents of waters are very often greater than those encountered in biological systems.

Systematic studies on the determination of Rn in natural waters from different geological formations have been carried out for some years (1957-1959) at the Radiogeological Research Center at the University of Nancy. The research has essentially been directed towards the adaptation of methods for use under difficult field conditions as well as their application in very diverse regions. A certain number of results have already permitted some conclusions to be drawn; the present paper continues and completes these.

Numerous methods have previously been employed for determining Rn in waters, atmosphere, rocks, and soils, but they are either already outmoded and slow, such as the ionization chamber (currently used in the U.S.S.R. for emanometry), or necessitate fragile and delicate equipment difficult to transport from place to place in the field, such as the impulse ionization chamber.

Following the work of Damon and Hyde and of van Dilla, we have succeeded in utilizing alpha-scintillation counting, with counting tubes, the inside walls of which are coated with zinc sulfide. These tubes are made of glass and comprise the measuring chamber coupled optically to a scintillation detector of the usual type; a reducing scaler completes the apparatus.--Auth.

3-235. Stonhill, L. G. THE ESTIMATION OF THE OXIDATION STATE OF PITCHBLEND IN ORES: *Geochim. et Cosmochim. Acta*, v. 19, no. 3, p. 168-176, 5 tables, July 1960, 14 refs.

The uranyl fluoride content of fully hydrofluorinated uranium oxides, whether pure or mixed with the oxides of a number of other metals, is a practical measure of the original UVI content. This observation forms the basis for determining the oxidation state of pitchblende when more precise methods are inapplicable. Metallic and carbonaceous contamination

tion must be absent, and the sulfide content of the ore must be reduced to the level of a few percent relative to the U content, by means of ore-dressing techniques. The method involves reacting the finely ground concentrate to constant weight with anhydrous hydrogen fluoride gas at a maximum temperature of 350°C. in a thermobalance modified for work with corrosive gases. Uranyl fluoride is leached from the product with cold saturated aqueous sodium fluoride, and uranium tetrafluoride is dissolved from the residue with hot ammonium oxalate solution. In each case, the extracted U is determined either spectrophotometrically or fluorimetrically. Application to problematical ores other than pitchblende, such as davidite, is envisaged.--Auth.

3-236. Shaw, William H.R. STUDIES IN BIO-GEOCHEMISTRY - I. A BIOGEOCHEMICAL PERIODIC TABLE. THE DATA: *Geochim. et Cosmochim. Acta*, v. 19, no. 3, p. 196-207, fold. table, July 1960.

Information of interest in biology, geology and chemistry has been collected from the literature and summarized in a biogeochemical periodic table. Available data on abundance, geochemical character, nutritional importance, electronegativity, complexing tendency, oxidation state, covalent and/or ionic radius, ionic potential, and ionization potential are reported for each element.--Auth.

3-237. Shaw, William H.R. STUDIES IN BIO-GEOCHEMISTRY - II. DISCUSSION AND REFERENCES: *Geochim. et Cosmochim. Acta*, v. 19, no. 3, p. 207-215, chart, table, July 1960, 82 refs.

A rule relating, within each periodic group, biological importance to ocean abundance is presented and discussed. Other biogeochemical relationships are analysed, and Frey-Wyssling's nutrient line is examined in the light of chemical developments. The possible existence of as yet unidentified nutritionally-essential trace elements is considered.--Auth.

3-238. Thode, Harry G., and others. SULPHUR ISOTOPE FRACTIONATION IN EARLY DIAGENESIS OF RECENT SEDIMENTS OF NORTHEAST VENEZUELA: *Am. Assoc. Petroleum Geologists, Bull.*, v. 44, no. 11, p. 1809-1817, 2 diag., 7 tables, Nov. 1960, 23 refs.

A study has been made of the S isotope ratios of different groups of S compounds in recent marine sediments from the Pedernales field of northeastern Venezuela at depths of 20, 80, and 160 ft. Data are presented for these ratios for sulfate S, elemental S, pyrite S, organic S, and those sulfides soluble in hydrochloric acid.

It was found that all the S including the organic materials in sediment samples obtained at the various depths are depleted in S^{34} within a range of 10-20‰ as compared with the original sea-water sulfate isotope ratio. The results indicate further that bacterial reduction of the marine sulfate is almost complete at depths of 12-20 ft. and that sulfates found at greater depths are probably formed by oxidation of pyrite *in situ* without any further isotope fractionation.

It is suggested that over very long periods of time, a partial exchange of S isotopes between sulfate and pyrite in close contact takes place, which could account for the high S^{34} depletion found for pyrite and sulfate of ancient sedimentary rocks.--Auth.

3-239. Tilton, G.R. VOLUME DIFFUSION AS A MECHANISM FOR DISCORDANT LEAD AGES: *Jour. Geophys. Research*, v. 65, no. 9, p. 2933-2945, 5 graphs, 4 tables, Sept. 1960, 30 refs.

The discordant U-Pb ages of 16 minerals having Pb^{207}/Pb^{206} ages of 2,400 to 2,700 million years (m.y.) closely fit a 2,800 to 600 m.y. chord when placed on a Pb^{207}/U^{235} - Pb^{206}/U^{238} diagram. These minerals are from the continents of North America, Africa, Europe, Australia, and Asia. If the data are interpreted as evidence of an episode of loss of Pb 600 m.y. ago from minerals that were crystallized 2,800 m.y. ago, it is strange that the same time of loss is indicated for all 4 continents. Moreover, most of the samples are from shield areas where no evidence has been found for metamorphic events 600 m.y. ago.

As an alternative explanation, Pb may be considered to diffuse continuously from crystals at a rate governed by a diffusion coefficient (D), the effective radius (a), and the concentration gradient. Calculations of the present-day Pb^{206}/U^{238} and Pb^{207}/U^{235} ratios as a function of the parameter D/a^2 yield ratios that lie on a 2,800 to 600 m.y. chord on a Pb^{206}/U^{238} - Pb^{207}/U^{235} diagram for losses of up to two-thirds of the Pb produced in the sample.

This method is capable of explaining the regularity of the age patterns from one continent to another and does away with the need for episodic losses of Pb simultaneously in all the areas 600 m.y. ago. Other examples have been found of suites of minerals with discordant ages which fit this hypothesis; they include minerals with apparent ages of 1,900, 1,700, and 1,100 m.y.

The behavior of U-Pb ages in several zircons from metamorphic rocks is indicative of an activation energy for diffusion of Pb of less than 10 kcal./mol. over a temperature range of 50° to 400°-600°C. This inference, when considered with available data for the diffusion of Ar from micas, is capable of explaining why U-Pb ages measured from zircon may be either greater or less than the K-Ar ages of coexisting mica.--Auth.

3-240. Hurley, Patrick M., and others. RELIABILITY OF GLAUCONITE FOR AGE MEASUREMENT BY K-Ar and Rb-Sr METHODS: *Am. Assoc. Petroleum Geologists, Bull.*, v. 44, no. 11, p. 1793-1808, illus., 3 diag., 9 tables, Nov. 1960, 18 refs.

Age measurements on glauconite by the K-Ar and Rb-Sr methods show a consistent variation with geological age with moderately small scatter. The results appear to fall 10-20% short of ages measured on micas associated with dated igneous rocks. K-Ar and Rb-Sr age values are closely concordant in the majority of samples. In no samples measured by the writers have glauconites yielded ages that are definitely higher than expected limits in the time scale.

Glauconites have interlayered structures. The interlayering involves mainly nonexpandable 10 Å layers and expandable (montmorillonitic) layers. The K content of glauconites is inversely proportional to the percent expandable layers. Furthermore, the percentage of expandable layers is greater in younger glauconites than in older. This suggests that the glauconite pellets continue to develop into purer mineral grains over long periods of time, with a decrease from 30% or more of expandable layers in young glauconite to about 10% in glauconite of early Paleozoic age. Almost without exception lower Paleozoic glauconite was found to contain more than 5% K.

Common Sr is adsorbed on basal plane surfaces of the expandable layers and is easily removed by exchange. It is commonly roughly proportional to the abundance of these layers. It does not affect the Rb-Sr age measurements, except in an increase of precision error in analysis. The only K-bearing mineral phase of importance that would be expected to be interlayered would be $1M_1$ muscovite. A study of the K-Ar ages in illitic shales suggests that the effect of minor amounts of interlayered authigenic muscovite phases in glauconite would not be significant because the age values shown by these phases are very similar to those given by glauconite. Detrital $2M_1$ muscovite occluded in the grains would presumably increase the observed age.

It is expectable that some K will be contained in the expandable layers, and that Ar generated in these may be lost. If the glauconite undergoes a slow purification with time, in which the expandable layers gradually become well ordered glauconite, up to about 20% of the mineral in lower Paleozoic samples may not be truly authigenic. It is believed that this is the cause of the apparently lower ages in the

Paleozoic. Superimposed on this effect is an expectable diffusion loss of the Ar in materials that have been deeply buried, giving rise to some unusually low values. However, in the normal sample of glauconite from thin sedimentary sections of the typical platform facies, the estimated diffusion loss of Ar is too small to account for the observed decrease in age. The agreement of the Rb-Sr ages also bears out this conclusion. The writers conclude that glauconite may have a limited use in the dating of unknown sediments because of the consistency indicated in world-wide comparisons, on an empirical glauconite age-scale.--Auth.

3-241. Emmons, R. C., and others. HIGH- AND LOW-TEMPERATURE PLAGIOCLASE: Geol. Soc. America, Bull., v. 71, no. 9, p. 1417-1420, 2 diags., Sept. 1960, 14 refs.

The plotted scatter of plagioclase optics and face poles is areal rather than lineal. This inhibits their reliable use for temperature determination as now understood.--Auth.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Geochemistry 3-230, 3-241; Sedimentary Petrology 3-259, 3-266, 3-268; Fuels 3-299, 3-326.

3-242. Aleksandrov, V. B. and Yu. A. Pyatenko. X-RAY STUDIES OF SOME METAMICT TITANONIO-BATES: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 124-127, table, Jan.-Feb. 1959, pub. Apr. 1960, 5 refs.

X-ray studies have been made of the euxenite-polycrase and priorite-blomstrandine series. All samples investigated were metamict and showed no diffraction pattern until heated. Reflections became clear after heating at 800°C . It was found that after heating for 1 hour at $1,100^\circ\text{C}$. the 2 series form a single isomorphous series, the members of which may be identified uniquely by X-ray measurements. A table of measured and calculated d values is provided.--F. Manheim.

3-243. Sapozhnikov, D. G., and A. I. Tsvetkov. PRECIPITATION OF HYDROUS CALCIUM CARBONATE ON THE BOTTOM OF LAKE ISSYK KUL: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 131-133, graph, 2 tables, Jan.-Feb. 1959, pub. Apr. 1960, 2 refs.

First occurrence of a stable hydrous calcium carbonate is described. The mineral forms capping on boulders in the surf zone in lake Issyk-Kul, as well as on the nearshore bottom. Chemical, differential thermal, X-ray, and other data show that the present occurrence is not one of the metastable hydrocalclites previously described by Johnston, Merwin, and Williamson, but an independent mineral. The empirical formula is $\text{CaCO}_3 \cdot 0.65\text{H}_2\text{O}$.--F. Manheim.

3-244. Golovanov, I. M. HUNTITE IN THE KURGASHINKAN DEPOSITS (UZBEK SSR): Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 128-130, graph, 2 tables, Jan.-Feb. 1959, pub. Apr. 1960, 5 refs.

First observations in the U.S.S.R. of huntite, $\text{Mg}_2\text{Ca}(\text{CO}_3)_4$ are described from the Kurgashinkan Pb-Zn deposits of Uzbekistan. The mineral occurs as a dull white, chalky fracture filling in slightly serpentinized dolomite. Accompanying minerals are hydromagnesite and opal. The present occurrence is believed to have been formed by the circulation of surface waters in fractures in the weathered mantle of serpentinites. A considerable predominance of Mg over Ca in the medium was a key factor. X-ray data, chemical analyses, qualitative spectrochemical analyses, and differential thermal data are provided.--F. Manheim.

3-245. Shamrai, I. A., and V. I. Radushev. GLAUCONITE FROM THE CRETACEOUS DEPOSITS ALONG THE BELAYA RIVER IN THE NORTHERN CAUCASUS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 134-137, 2 figs., 2 tables, Jan.-Feb. 1959, pub. Apr. 1960, 10 refs.

A persistent horizon of glauconitic sands and sandstones from the Lower Cretaceous of the northern Caucasus is described. Results of chemical, differential thermal, and X-ray analyses, as well as optical and dehydration data on the glauconite, are given. The glauconite occurs together with thin seams and concretions of siderite having erratic dendritic forms. Inclusions of glauconite are commonly found within the sideritic concretions. It is concluded that the glauconite formed at an early stage in diagenesis, and that siderite was formed later when reducing conditions had reached a maximum.--F. Manheim.

3-246. Kazenkina, G. A. LAUMONTITE IN THE CONGLOMERATES OF THE BEREZOVSKAYA SERIES IN THE TUNGUI BASIN (WESTERN TRANS-BAIKAL REGION): Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 76-77, Jan.-Feb. 1959, pub. Apr. 1960, 4 refs.

The zeolite, laumontite, is found as an authigenic mineral in interspaces between sand grains and as

coatings on rock fragments in the Bereзовskaya conglomerates. It is believed that the present laumontite formed under reducing conditions during diagenesis of the conglomerate and that biogenic processes played an important role in creating conditions favorable for the development of the mineral.--F. Manheim.

3-247. Copeland, Lawrence L., and others. **THE DIAMOND DICTIONARY**: 315 p., approx. 200 illus., Los Angeles, Gemological Institute of America, 1960, 31 refs.

An exhaustive and profusely illustrated compilation of all important terms relating to the gem diamond. Diamond grading, evaluation, market controls; famous and large diamonds, including noted stones of American origin; cutting; properties; mines and mining methods; and many other aspects of the industry are covered. Though designed primarily to assist the jeweler and gemologist, this compilation contains numerous terms of value to the technician interested in obtaining background material. Valuable discussions are included upon the irradiation of diamonds, previous attempts to synthesize diamond, and modern successful techniques. Chapters are divided alphabetically. Appended to the dictionary portion, which comprises virtually the entirety of the book, are a number of sections on the selection and use of color comparison diamonds, sales and lecture aids, comparison of various grading systems, and other topics primarily of interest to the jeweler.--J. Sinkankas.

3-248. Bryant, Stearns J. **FLUORESCING PEGMATITE IN MAINE**: *Rocks & Minerals*, v. 35, no. 5-6, p. 217-219, May-June 1960.

Widespread, often intense fluorescence rivaling that of some Franklin, New Jersey, minerals has been noted upon broad areas of pegmatite recently exposed by mining operations at the Mt. Rubellite quarry at Hebron, Oxford Co., Maine. Short wave

U.V. produces the greater part of the fluorescence, although a few specimens are brighter under long wave U.V. Golden fluorescence is probably due to manganoapatite and green fluorescence to hyalite. Causative agents of blue, yellow, and rose-purple fluorescence have not been identified. Spectrographic analyses and radioactivity tests yielded negative results in identifying causative agents.--J. Sinkankas.

3-249. Mitchell, Richard S., and Richard F. Pharr. **STRONTIUM MINERALS FROM WISE COUNTY, VIRGINIA**: *Virginia Minerals*, v. 6, no. 4, p. 1-4, 2 illus., Oct. 1960, 11 refs.

The 2 Sr minerals, celestite and calciostrontianite occur in vugs in dolomite near East Stone Gap, Wise County. Celestite occurs as crystals in association with calciostrontianite globules and calcite scalenohedrons. One fibrous specimen of celestite has been found. Minor associated minerals include sphalerite, fluorite, glauconite, illite, starkeyite, and hexahydrite. No commercial concentrations of Sr minerals have been found in Virginia to date.--M. Russell.

3-250. Kulakova, L.S. **MINERALOGY OF MODERN SEDIMENTS OF THE SOUTHEASTERN SHORE OF THE CASPIAN SEA**: *Akad. Nauk SSSR, Doklady, Earth Sci. Secs.*, in English translation, v. 124, no. 1-6, p. 173-176, 2 maps, table, Jan.-Feb. 1959, pub. Apr. 1960, 7 refs.

Analyses of detrital minerals have been carried out in an effort to define the source and distribution of the sediments. It is concluded that the terrestrial sediments are derived mainly from shore abrasion and wind transport, especially from the Kuba Dag structure. In addition, local mud volcanoes and bed-rock outcrops influence the composition of the sediments to some extent.--F. Manheim.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Geochemistry 3-230; Sedimentary Petrology 3-270; Mineral Deposits 3-293.

3-251. Woodland, Mary Vogt. **DATA OF ROCK ANALYSES - VII. BIBLIOGRAPHY AND INDEX OF ROCK ANALYSES IN THE PERIODICAL AND SERIAL LITERATURE OF THE REPUBLIC OF IRELAND AND OF NORTHERN IRELAND**: *Geochim. et Cosmochim. Acta*, v. 20, no. 2, p. 149-153, Oct. 1960, refs.

The bibliographic data of analyses of igneous and metamorphic rocks appearing in British geological literature are being published in 3 parts. The first part, pertaining to analyses in the Scottish literature from 1914 through 1953, has been published [*GeoScience Abstracts* 1-3105]. This paper is the second of the 3 parts, and deals with the analyses published between 1914 and 1953 in the scientific journals of the Republic of Ireland and of Northern Ireland. A third part, for England and Wales, will follow at a later date. As is the case with Scotland, no analysis of a rock from an English or Welsh locality appears in the Irish literature examined; in fact, only one analysis from Scotland is recorded. Some analyses of rocks from the Republic of Ireland and Northern Ireland are first published in Scottish and in English

journals; these are not included in the present paper, but will be found in parts 1 and 3.

Part VII in this series consists of a list of the 12 periodicals and serials examined, an annotated bibliography of 20 references taken from 5 publications, a geographic index to the 3 countries represented, subdivided into counties, and a rock-name index to the 48 analyses contained in the references.--From auth. pref.

Pts. I-V of the Data of Rock Analyses series dealt with Africa, New Zealand, Iceland, and Australia, Pts. IV, V, and VI were listed as *GeoScience Abstracts* 1-203, 1-1244, and 1-3105.

3-252. Baragar, W. Robert A. **PETROLOGY OF BASALTIC ROCKS IN PART OF THE LABRADOR TROUGH**: *Geol. Soc. America, Bull.*, v. 71, no. 11, p. 1589-1643, 9 illus., on 4 pls., fold. map, 20 figs. incl. illus., 2 maps, secs., charts, diags., graphs, 13 tables, Nov. 1960, 102 refs.

Basalts and sedimentary rocks in the eastern half of the Labrador trough are profusely intruded by gabbro sills. In the Ahr Lake area, Quebec, where the igneous rocks were studied in detail, the gabbros are

divided into normal gabbros, leopard rocks, and metagabbros. Metagabbros, which are confined to the eastern part of the area, are equivalent to normal gabbros except for 2 unusual varieties, leuco- and melanometagabbros.

Normal gabbro sills have differentiated into olivine-bearing lower, and pegmatitic upper, portions. The pegmatite of one sill (albite gabbro pegmatite) has sodic plagioclase in contrast with andesine in other pegmatites and a mesostasis interpreted as devitrified glass. Glass formation is attributed to volatile deficiency in the magma, but development of sodic plagioclase may have been due to later metamorphism facilitated by the presence of glass.

Leopard rock is a coarse-grained feldspathic gabbro spotted with 6- to 15-cm. aggregates of altered plagioclase. Sills of leopard rock have narrow zones of medium-grained, sparsely porphyritic gabbro along their margins, and some are composite with intrusions of normal gabbro along their centers. Leopard rock is probably equivalent to normal gabbro with a high concentration of plagioclase, and it may have formed by partial melting of the mantle at high pressures or under conditions of moderately high water pressure. Magma with a load of suspended plagioclase may assume a flow structure upon intrusion such that plagioclase is concentrated in a central sheet and the margins are free of plagioclase clusters. Thus the marginal zones with few feldspathic clots are explained.

Melano- and leucometagabbros occupy the lower and upper parts respectively of 2 sills and are separated by a narrow gradational zone. Each also occurs separately. Melanometagabbro is predominantly amphibole but shows relic olivine structures; leucometagabbro is predominantly altered plagioclase. Sills of melano- and leucometagabbros cannot be due to normal differentiation, and their origin is uncertain.

Petrographic, mineralogical, spectrographic, and chemical data for gabbros and basalts are given. Normal gabbros are tholeiites which show an Fe-rich trend similar to the Skaergaard trend but with negligible alkali enrichment. Basalts of the area are equivalent to the parent magma of the normal gabbros, and differentiation was *in situ*. Low K and Sr are characteristic of the province. Trace-element behavior is similar to that in other tholeiitic provinces.

Metamorphism decreases westerly across the Ahr Lake area from quartz-albite-epidote-biotite subfacies of the greenschist facies through quartz-albite-muscovite-chlorite subfacies to subgreenschist facies rocks. Local development of pumpellyite and prehnite in the latter may indicate the zeolite facies.--Auth.

3-253. Taubeneck, William H., and Arie Polderwaard. GEOLOGY OF THE ELKHORN MOUNTAINS, NORTHEASTERN OREGON: PART 2. WILLOW LAKE INTRUSION: Geol. Soc. America, Bull., v. 71, no. 9, p. 1295-1321, 22 illus., 4 maps, 6 diag., 4 tables, Sept. 1960, 47 refs.

The Willow Lake intrusion is funnel-shaped with contacts inclined inward at 60°-70° and has a sheet-like appendage to the SW., inclined NW. at 50°. The pluton lies athwart the southern contact of the Bald Mountain batholith and was emplaced before the main batholithic phases. It contains normal metagabbroic rocks, rhythmically layered rocks similar to those described from the Stillwater and Skaergaard intrusions, and abnormal banded rocks in which the

minerals are elongated and arranged with their longer axes at high angles to the banding. Similar abnormal banded rocks have been found in a number of localities in Oregon and California, invariably in steep-walled intrusions of small size, including dikes a foot or less in width. The Willow Lake type of rhythmical layering cannot have been formed by a process combining gravitative sedimentation of crystals with convection currents in the magma, such as accounts for Skaergaard-type layered rocks. The Willow Lake-type layered rocks probably formed by undercooling and crystallization in the oversaturated (metastable) region, combined with intermittent convective and turbulent currents, in a magma near a univariant condition.

Banded rocks of this type may be expected in epizonal metamorphic regions in steep-walled mafic intrusions, emplaced late in the regional metamorphic cycle. Criteria for so-called gravity stratification are examined; the various features of density stratification may in part be due to processes other than those operating under the influence of gravity. The perpendicular feldspar rock of the Skaergaard intrusion and the harrisite structure of layered peridotites from the island of Rhum are cited as products of moderate undercooling of magma in a bivariate condition. Translation-gliding effects and a set of conjugate shears developed in Willow Lake banded rocks are attributed to stresses in the crystal mush resulting from magma movements past surfaces of crystallization. The role of diffusion in the interstitial melt is discussed, and the formation of monomineralic layers in the Willow Lake banded rocks is attributed to diffusion between interstitial melts of adjacent bands of contrasting mineralogy and reactions between the melts and the surrounding solid phases.--Auth.

3-254. Orville, P.M. PETROLOGY OF SEVERAL PEGMATITES IN THE KEYSTONE DISTRICT, BLACK HILLS, SOUTH DAKOTA: Geol. Soc. America, Bull., v. 71, no. 10, p. 1467-1489, 6 illus., 11 figs. incl. maps, secs., diag., 11 tables, Oct. 1960, 14 refs.

Three pegmatites in the vicinity of Keystone, South Dakota, of simple mineralogy and without concentric zoning have been studied in detail. They occur within Precambrian quartz-mica schist and are peripheral to the Precambrian Harney Peak granite. Two are concordant to schistosity and bedding of the country rock, and the third is sharply discordant. These pegmatites are of very similar average modal and chemical compositions. Samples of the Harney Peak granite from 2 localities have compositions close to those of the pegmatites. All the compositions fall near the quartz-feldspar field boundary in the "synthetic-granite" system. The average composition of pegmatites and granites is approximately 30% quartz, 44% plagioclase, 17% microcline, 8% muscovite, and less than 1% tourmaline, garnet, and apatite.

Large perthite crystals appear to have grown, at least in part, by pushing aside previously crystallized fine-grained quartz and plagioclase. This relationship is compatible with experimental findings which indicate that in a melt of this composition, crystallization, whether of the 1- or 2-feldspar types, should begin with quartz and a Na-rich feldspar.

At one locality thin, steeply dipping tabular pegmatites are sharply separated into an upper porphyritic perthite-bearing unit and a lower fine-grained albite-quartz unit. The upper, perthite-bearing unit of the layered pegmatites has a com-

position near that of the "granite minimum" in the "synthetic-granite" system and is thought to represent a rest liquid which has been separated from the phases which crystallized earlier.

The pegmatites and granite are believed to have been intruded as magma derived from a common source.--Auth.

3-255. Verboloz, S.E. NEW DATA ON THE IGNEOUS ROCKS OF THE EASTERN PART OF THE DONETS BASIN: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 179-181, map, 2 diag., Jan.-Feb. 1959, pub. Apr. 1960, 3 refs.

Petrology and mineralogy of andesite porphyry dikes in the mines of the eastern Donets basin is described. The contacts of the dikes are sharp, and contact metamorphism is very limited on the surrounding argillites and anthracites.--F. Manheim.

3-256. Koschmann, A.H. MINERAL PARAGENESIS OF PRECAMBRIAN ROCKS IN THE TENMILE RANGE, COLORADO: Geol. Soc. America, Bull., v. 71, no. 9, p. 1357-1370, 24 illus., 2 maps, 2 tables, Sept. 1960, 17 refs.

A Precambrian complex of granulite, gneiss, and migmatite, intruded by numerous plutons of granitic rocks correlated with the Silver Plume granite, is exposed in a long narrow belt along the crest and upper slopes of the Tenmile Range, Colorado. The metamorphic rocks are predominantly felsic; bands, lenses, and irregular bodies of mafic rocks rich in biotite, hornblende, and locally in sillimanite and garnet, are interlayered with the felsic rocks. The major lithologic variations in the metamorphic rock complex are believed to be due chiefly to variations in the original sedimentary rocks, which probably were interbedded sandstone, shale, and limestone.

The metamorphic rocks and the Silver Plume granite reveal the age relations of quartz and the feldspars, and these relations afford considerable information on the origin and progressive transformation of the rocks. Quartz is the earliest mineral in the metamorphic rocks and is probably a relict mineral of a sandstone. It has been partially replaced by feldspar. It occurs chiefly in irregular clusters, some of which show sutured grains, enclosed in a ramifying network of feldspar. Irregular small apophyses, barbs, and prongs of feldspar penetrate the quartz clusters along grain boundaries and healed fractures in the quartz. In some of the least feldspathized quartzose metamorphic rocks the feldspar is clearly interstitial to the quartz. Quartz also occurs in feldspar as small spherical inclusions. The relations of the quartz to the feldspars show clearly that a quartzose host rock was replaced by feldspar along quartz grain boundaries, pre-existing healed fractures, and margins of shadowy areas in strained quartz grains.

The textural relations of the other principal minerals in the metamorphic rocks show that plagioclase formed earlier than the microcline and that the micas were the last of the principal minerals to form.

Identical paragenetic relations are found in the Silver Plume granite, and the writer concludes that the Silver Plume granite was derived by partial fusion of quartzose metamorphic rocks.--Auth.

3-257. Compton, Robert R. CONTACT METAMORPHISM IN SANTA ROSA RANGE, NEVADA: Geol. Soc. America, Bull., v. 71, no. 9, p. 1383-

1416, 16 illus., 5 maps incl. fold. col. geol. map, scale approx. 1 in. to 5,000 ft., sec., diag., 4 tables, Sept. 1960, 38 refs.

The metamorphic rocks of the Santa Rosa Range of N.-central Nevada represent a sequence of Upper Triassic (and Jurassic?) sediments that was 20,000 ft. thick before it was strongly folded, metamorphosed, locally faulted, and intruded by granitic stocks. Each of the 6 formations is dominantly metapelitic, although quartzitic, calcareous, and dolomitic rocks are widespread. All the rocks were converted to metamorphic assemblages of quartz, albite, muscovite, chlorite, and carbonates before and during the regional folding. The 9 stocks consist mainly of sodic granodiorite, but adamellite, trondhjemite, and tonalite are locally abundant. Early chilled apophyses show the magmas originally contained few if any crystals, and structural relationships prove the stocks are dominantly cross-cutting (stoped?) bodies.

Forty-six chemical analyses of metapelites show that most of the phyllites have percentage compositions close to: SiO_2 , 61.3; TiO_2 , 1.0; Al_2O_3 , 19.3; Fe_2O_3 , 1.2; FeO , 5.5; MnO , 0.07; MgO , 1.9; CaO , 0.6; Na_2O , 1.5; K_2O , 3.0; H_2O , 3.9; P_2O_5 , 0.15. Besides dehydration, the only metasomatism during progressive contact metamorphism was minor desilication and addition of Fe around one stock.

Although their compositions are similar, the rocks developed 4 combinations of critical minerals in the outer and intermediate parts of the aureoles, namely, cordierite-biotite, cordierite-andalusite-biotite, staurolite-andalusite-biotite, and andalusite-biotite. Textures and structures show that directed stress was equally effective in all these rocks. Around most of the stocks, contact metamorphism began with the reaction of chlorite and muscovite to biotite and andalusite; cordierite shortly joined these minerals. Near the stocks, muscovite and biotite were converted to K feldspar, cordierite, and Fe ores, and sillimanite formed locally. Staurolitic rocks occur locally in the outer part of one of the cordieritic aureoles and form the major assemblage of another aureole, apparently having remained stable (or metastable) to the point where sillimanite formed, very near the stock. Andalusite-biotite rocks, typically mixed with the staurolitic rocks, formed also in the outer parts of the cordieritic aureoles, as well as by retrogressive reaction of cordierite to biotite deeper within these aureoles. Differences in original composition were considered as a possible reason for the 4 assemblages, and the cordierite-biotite rocks can be explained in this way; the others, however, cannot. The staurolitic assemblage apparently formed where magmatic fluids catalyzed the lower-temperature reactions, whereas the cordieritic rocks formed in drier aureoles where reactions could not go appreciably until higher temperatures were reached. Mineral assemblages of basaltic, calcareous, and impure dolomitic rocks show that the aureoles are almost entirely in amphibolite facies and perhaps partly in greenschist and pyroxene hornfels facies.

In the final stages of igneous crystallization, fluids from the stocks desilicated the hornfels locally and added one or both alkalis. Later, cooler fluids rehydrated most of the contact-metamorphic rocks and added considerable K_2O to them.

This study emphasizes the influence of magmatic water on contact-metamorphic reactions; the relationships suggest that the rapid rate of heating by intrusive magma may be the most significant characteristic of contact, as compared to regional meta-

morphism.--Auth.

3-258. Moor, G.G., and S.I. Zykov. **ALKALINE ROCKS OF THE NORTHERN BORDER OF THE SIBERIAN PLATFORM AND THE ISOTOPE COMPOSITION OF THE LEAD IN THEM:** Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 29-31, table, Jan.-Feb. 1959, pub. Apr. 1960, 4 refs.

Geological investigations carried out in the lower

course of the Kotui and Maimecha rivers have found a complex of ultrabasic and alkaline rocks which are considered comagmatic. The age of the complex is placed at late Permian to early Jurassic.

The isotopic composition of galenas found in syenitic veins through the complex gave the following results: $Pb^{206}/Pb^{204} = 17.98$; $Pb^{207}/Pb^{204} = 15.36$; $Pb^{208}/Pb^{204} = 37.65$. Since the Pb ratios from both trap and alkaline rocks of the Kotui River complex are similar, it is concluded that the parent material of both was a basaltic magma.--F. Manheim.

10. SEDIMENTARY PETROLOGY

See also: Geophysics 3-176, 3-177; Geochemistry 3-226, 3-232, 3-238; Mineralogy 3-243, 3-245, 3-250; Fuels 3-303, 3-305, 3-308, 3-315.

3-259. Ginzburg, A.I. **SULFIDE CONCRETIONS IN COAL BEDS AT THE ANGREN DEPOSIT:** Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 189-193, 3 figs. table, Jan.-Feb. 1959, pub. Apr. 1960.

Detailed analysis has been made of the sulfide concretions in the Middle Jurassic coal beds of the Angren field. The form of occurrence is variable: loaf-shaped, lenticular, nodular, tabular, spherical, and pseudomorphous after plant remains. In the latter type the structure is often intimately preserved and indicates formation contemporaneously with the accumulation of plant material. Minerals found are chiefly pyrite with subordinate marcasite and melnikovite. Marcasite forms the mineral replacements of plant fragments in many cases, while the interspaces between fragments is filled with pyrite regarded to have formed later.

Spectrographic data show that the concretions contain, in addition to Fe and S, 0.1-1% As, 0.1-0.3% Zn, and trace amounts of Al, Mn, Mo, Cu, Pb, Ge, and Si.--F. Manheim.

3-260. Krynine, Paul D. **ON THE ANTIQUITY OF "SEDIMENTATION" AND HYDROLOGY (WITH SOME MORAL CONCLUSIONS):** Geol. Soc. America, Bull., v. 71, no. 11, p. 1721-1725, Nov. 1960, 30 refs.

The ancient Greek philosophers held very modern views on sedimentation. Democritus discovered shape sorting of pebbles on beaches; Aristotle worked out the mechanical aspects of pebble abrasion; Plato produced truly post-Huttonian descriptions of erosion and deposition around Athens, and he also brought forth, 1,900 years before Palissy, the correct pluvial theory for the origin of springs and rivers.

Since some leading modern physicists have rediscovered the fruitfulness of certain basic principles of early Greek scientific thought, perhaps geologists should also look into it.--Auth.

3-261. Krinsley, David H. **ORIENTATION OF ORTHOCERAONE CEPHALOPODS AT LEMONT, ILLINOIS:** Jour. Sed. Petrology, v. 30, no. 2, p. 321-323, diag., June 1960, 8 refs.

Orthoceraone cephalopods and crinoid orientations were studied in middle Silurian Waukeshaw beds in a quarry 1/2 mi. N. of Lemont, Illinois, and between the Sanitary and Ship Canal and the Des Plaines River. Orientation readings on 106 specimens were made to determine in which direction they were lying.

Two trends were found, the major, WNW., and the minor, SSW. Crinoid stems were mainly oriented in the same directions. These directions indicate a wind and current from the WNW. Such orientation studies show that it is possible to examine certain ecological measures over essentially "instants" in time.--D. Carroll.

3-262. Wilson, Charles W., Jr., and Richard G. Stearns. **PENNSYLVANIAN MARINE CYCLOTHEMS IN TENNESSEE:** Geol. Soc. America, Bull., v. 71, no. 10, p. 1451-1465, 9 figs. incl. maps, secs., diags., 2 charts, Oct. 1960, 13 refs.

In contrast to prevailing concepts, Pennsylvanian (Pottsville) sedimentary rocks of Tennessee, except for coals and adjacent strata, are considered herein to have been deposited in marine water of considerable depth.

Blanket sandstones, restricted to the lower third of the column, were deposited by southwestward-moving currents in a shallow (i.e. tens of feet deep) arm of the sea, which was greatly restricted by Appalachia to the SE. and the emergent Cincinnati arch to the NW. Digitate sandstones occur in the upper beds and extend westward partly across the coal field. These digitate sandstones were deposited on the E. flank of the Interior Sea where sediment-laden water moved down the slope into deeper water; each tongue may have matched a stream mouth which had its headwaters in Appalachia. At this time the Cincinnati arch was buried. Shale blankets were deposited in deep, quiet water. Widespread coal zones mark periods of abrupt withdrawal of the sea.

On the assumption that the bulk of the strata are marine, the writers have applied the concept of 4-phase cyclothem deposition and divided the lower third of the column into 5 cyclothems. Phase 1 is commonly represented by coal beneath blanket sandstones. Phase 2 is represented by a widespread marine sandstone blanket deposited in shallow water; local coals within these sandstones indicate local filling up of the shallow sea by rapid sedimentation adjacent to Appalachia. Phase 3 is represented by the widespread coal zone in normal position above the blanket sandstones. Phase 4 is represented by a widespread shale blanket deposited in a deep sea. Stratigraphic cross sections and paleogeographic block diagrams illustrate each phase.--Auth.

3-263. Pryor, Wayne Arthur. **CRETACEOUS SEDIMENTATION IN UPPER MISSISSIPPI EMBAYMENT:** Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 9, p. 1473-1504, 13 maps, sec., 7 diags., graph, 8 tables, Sept. 1960, 74 refs.

The Cretaceous (Gulfian) sediments in the upper

Mississippi embayment are the result of deltaic deposition. The deltaic system (the "McNairy Delta") centered in the northeastern end of the embayment and dispersed the sediments toward the SW. Three major environments of deposition are represented by the embayment Gulfian sediments: 1) the fluvial and upper deltaic environment, represented by the nonmarine, arenaceous Coffee and McNairy formations; 2) the pro-delta shelf environment, represented by the marine, calcareous, and argillaceous Selma and Owl Creek formations; and 3) the transitional delta platform environment, represented by the marine, argillaceous Coon Creek formation and the marine parts of the arenaceous McNairy and Coffee formations.

Several regional trends are apparent from subsurface studies: the sedimentary body thickens from less than 100 ft. in the N. to more than 1,100 ft. in the SW.; the clastic ratio decreases from greater than 2:1 in the N. to less than 1:2 in the S.; the sediments range from totally nonmarine in the N. to totally marine in the SW.

McNairy formation sands are first-cycle proto-quartzites. The heavy-mineral assemblages of the McNairy formation and the adjacent Coffee, Selma, Coon Creek, and Owl Creek formations are identical and are composed chiefly of kyanite, staurolite, tourmaline, zircon, and sillimanite, with minor amounts of other minerals.

Major sand bodies in the McNairy formation trend SW., parallel with the paleoslope and the regional transport direction. Local trends in the McNairy formation can be predicted from studies of cross-stratification and fabric.

The Gulfian sediments in the upper Mississippi embayment were derived chiefly from the high-rank metamorphic rocks of the Blue Ridge and Piedmont plateau of the southern Appalachians and were transported to the embayment by a single, large stream system. Humid, temperate to subtropical climatic conditions were prevalent in both the source and depositional areas. The depositional history involves 2 transgressive-regressive cycles of late Cretaceous seas, separated by an erosional interval. The initial transgressive-regressive cycle resulted in the deposition of the Coffee-Selma-Coon Creek-McNairy sequence, and the later cycle, apparently more rapid and widespread, resulted in the deposition of the Owl Creek-Prairie Bluff sequence.

A depositional model, postulated for the Cretaceous (Gulfian) upper Mississippi embayment, includes as primary elements 1) basin geometry: a shallow, open-end, intracratonic basin, plunging SW.; 2) depositional pattern: deltaic with longitudinal filling; 3) paleoslope: parallel with basin axis, toward the SW.; 4) depositional strike: normal to paleoslope, NW.-SE.; 5) transport direction: parallel with paleoslope and normal to depositional strike, toward the SW.; 6) sand trends: parallel with transport direction and paleoslope and normal to depositional strike, toward the SW.; 7) sedimentary association: protoquartzite grading down paleoslope into impure carbonates; and 8) tectonic activity: mild subsidence and uplift.--Auth.

3-264. Davis, George H. THICKNESS AND CONSOLIDATION OF DEEP-SEA SEDIMENTS: A DISCUSSION: *Geol. Soc. America, Bull.*, v. 71, no. 11, p. 1727-1728, Nov. 1960, 9 refs.

Hamilton [GeoScience Abstracts 1-3120] concluded that in most sediments excess pore-water pressure is equal to zero - that is, the hydrostatic pressure is at atmospheric pressure. This note points out

that in terrestrial environments the occurrence of artesian water (excess pore-water pressure) is commonplace and widespread and that such excess pressure is the source of energy for flowing water wells and for many flowing oil wells, "gushers," or "blow-outs." --Auth.

3-265. Baird, David M. OBSERVATIONS ON THE NATURE AND ORIGIN OF THE COW HEAD BRECCIAS OF NEWFOUNDLAND: Canada, *Geol. Survey, Paper* 60-3, 26 p., map, table, 1960, 12 refs.

Reviews previous theories of origin of conglomeratic, limestone breccias on the W. coast of Newfoundland. Two distinct facies of Cambrian and Ordovician rocks occur, 1) a normal sedimentary sequence rimming the Long Range complex, and 2) shales and thin-bedded limestones with intercalations of coarse breccias as an outside or western fringe that is widest between Rocky Harbour and Daniels Harbour. The term "Cow Head type breccia" is proposed as a general term for the breccia-bearing sequence which includes chaotic megabreccia, shingle breccia, erratic boulder breccia and common limestone conglomeratic breccia.

The breccias parallel the present Long Range scarp which suggests that the same scarp or its ancestor, or a parallel scarp, controlled their formation. Frosted grains of bluish quartz, like that in the Long Range gneisses, and found in the matrix of the breccia, suggest westward movement. Boundaries of breccia beds, internal structures, composition and age of fragments, and broad stratigraphic relations suggest several origins for a variety of breccias. Thus no single mechanism seems adequate to account for all breccias although submarine sliding is clearly fundamental as suggested by earlier writers. Breccias derived from turbidity currents, shatter, creep, and wave action are probably also present.--Auth.

3-266. Logvinenko, N.V., and others. THE MINERALOGY AND PETROGRAPHY OF THE TAVRIDA FORMATION IN THE CRIMEA: *Akad. Nauk SSSR, Doklady, Earth Sci. Secs.*, in English translation, v. 124, no. 1-6, p. 194-197, table, Jan.-Feb. 1959, pub. Apr. 1960, 5 refs.

The Tavrida formation is regarded as being of Upper Triassic to Lower Jurassic in age and is made up of sandstones, siltstones, and mudstones. Carbonates are absent but carbonate concretionary bodies are widespread in the mudstones. A list of minerals found is included. Diagenetic minerals include sulfides, calcite, and minerals of the magnesite-siderite series, in particular sideroplesite. The formation is regarded as a clastic noncarbonate flysch laid down partly under stagnant conditions.--F. Manheim.

3-267. Baskakov, M.P. PHOSPHATIC FACIES IN THE PALEOZOIC ROCKS OF KYZYL KUM: *Akad. Nauk SSSR, Doklady, Earth Sci. Secs.*, in English translation, v. 124, no. 1-6, p. 177-178, illus., Jan.-Feb. 1959, pub. Apr. 1960, ref.

Silurian calcareous shales containing apatite have been found in the Auminzatau region of Kyzylkum. These beds are considered to have been the source of P for the turquoise known from this region since ancient times. Spectrographic and chemical analyses of the limestones are provided.--F. Manheim.

3-268. Marakushev, A. A. SUPERGENE BORATES IN CAMBRIAN DOLOMITES ON THE ALDAN SHIELD: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 198-201, illus., sec., 2 tables, Jan.-Feb. 1959, pub. Apr. 1960, 3 refs.

A zone of rich mineralization in Lower Cambrian dolomites in association with the Lebedino Cu-Au deposit is described. A branching network of ludwigite mineralization and calcite-clinohumite skarn accompanied by magnetite shows later superimposition of pyrite-chalcocopyrite mineralization. Both the dolomites and the underlying Archean metamorphics are intruded by a variety of Mesozoic plutonic rocks. --F. Manheim.

3-269. Nechaev, S. V. THE ORIGIN OF DOLOMITES AND DOLOMITIZED LIMESTONES ALONG THE SOUTHWESTERN BORDER OF THE DONETS BASIN: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 89-91, Jan.-Feb. 1959, pub. Apr. 1960, 10 refs.

Two origins of the dolomitized limestones along the southwestern border of the Donets basin have been proposed: 1) primary sedimentary or sedimentary-diagenetic, 2) hydrothermal metasomatic. The spatial relationship of the dolomites to zones of tectonic disturbance associated with Hercynian magmatism and the direct relationship between the dolomites and small intrusions and fractures have led the author to regard the origin of the dolomites as being hydrothermal-metasomatic. It is believed that the Mg in the hydrothermal solutions was derived from various silicate rocks encountered along the path of the hydrothermal solutions. --F. Manheim.

3-270. Anderson, Alfred T., Jr. DIAGNOSTIC TEXTURES OF SOME WELDED TUFFS FROM SOUTHEASTERN IDAHO: Illinois State Acad. Sci., Trans., v. 53, no. 1/2, p. 25-35, 4 illus., map, sec., table, 1960, 12 refs.

The rocks of a 250-ft. stratified sequence of late Tertiary (Pliocene ?) rhyolitic volcanics in southeastern Idaho show considerable textural variability. Vitroclastic tuffs are associated with lavas and welded tuffs, in both of which there is extensive

devitrification. Units of welded tuff have a maximum thickness of 75 ft.

Lavas and welded tuffs are virtually indistinguishable in the field, but in most cases they can be separated on the basis of microtexture.

The welded tuffs are characterized by abundant discrete areas which correspond in size and generalized shape to the shards in neighboring vitroclastic tuffs. Such areas are bounded by rounded rather than cusped outlines. Glassy areas are usually enclosed by zones of microscopic dust and cryptocrystalline material. Palimpsest glassy areas may be recognized in devitrified welded tuffs by the difference in grain size between these areas and the surrounding matrix. Bands of dust frequently surround devitrified areas.

The glassy lavas often have intricately folded flow bands and perlitic cracks. Elongated vesicles and flow patterns around phenocrysts are common in the lavas and can be recognized in the devitrified flows. --Auth.

3-271. Subba Rao, M. ORGANIC MATTER IN MARINE SEDIMENTS OFF EAST COAST OF INDIA: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 10, p. 1705-1713, map, table, Oct. 1960, 17 refs.

The amount of organic matter has been determined in 75 samples of the continental shelf sediments of the northern part of the E. coast of India. The results of this study corroborate the view that the fine-grained sediments are generally richer in organic matter content than the coarse-grained. The sediments of the continental shelf off the E. coast of India are poor in organic content as compared with the world's average for nearshore sediments. The low content of organic matter in these sediments has been attributed firstly to the probable low plankton production in the overlying waters of the Bay of Bengal and secondly to the extreme dilution of land humus by the inorganic detrital matter attended by intense oxidation conditions during sedimentation and after depositions which is a common feature in tropical seas. Finally, the potentialities of these sediments as future source beds of petroleum do not appear to be encouraging even though there are sandy and oolitic sediments which can act as good reservoirs when consolidated. --Auth. summ.

II. GEOHYDROLOGY

See also: Geomorphology 3-86; Geophysics 3-173; Sedimentary Petrology 3-260.

3-272. Foley, Joseph. COMPUTER APPLICATIONS IN GROUNDWATER HYDROLOGY: Am. Soc. Civil Engineers, Irrigation & Drainage Div., Jour., v. 86, no. IR3, pt. 1, p. 83-99, 10 figs. incl. diag., table, Sept. 1960, refs.

The Theis equation is adapted for computer solution of 4 types of problems inherent in many industrial well-water developments. These types are 1) drawdown computation, 2) aquifer constants "T" and "S," 3) well spacing, and 4) capacity of a well system. Objectives, equations, computation sequence, print-out of results, and computer time are outlined for each problem. --Auth.

3-273. McDonald, H. R., and Dart Wantland. GEOPHYSICAL PROCEDURES IN GROUND WATER

STUDY: Am. Soc. Civil Engineers, Irrigation & Drainage Div., Jour., v. 86, no. IR3, pt. 1, p. 13-26, map, sec., 5 diags., Sept. 1960, 2 refs.

Although geophysical methods of subsurface exploration were developed primarily for, and have been used most extensively by, the petroleum industry, many of the procedures apply equally well in the search for ground water. The principles of the geophysical methods most useful in ground-water exploration are described and illustrated. In addition, a new application of the electrical bore-hole logging is described which may be of great importance in locating leaky zones in irrigation canals. --Auth.

3-274. Peck, A. J. THE WATER TABLE AS AFFECTED BY ATMOSPHERIC PRESSURE: Jour. Geophys. Research, v. 65, no. 8, p. 2383-2388,

2 diags., 3 graphs, Aug. 1960, 5 refs.

In the common situation where air is entrapped in the water, the water table height will vary with atmospheric pressure. The magnitude of this effect must be known before water-table changes can be related with any precision to other factors such as evapotranspiration, infiltration, and drainage.

A theory of this effect is developed and the influences of hysteresis and solubility are discussed. It is shown that the maximum rate of change of water-table height with air pressure occurs when the water table is at the surface of the soil.

The experiments clearly show the influence of hysteresis, and the results agree excellently with the theoretical predictions.--Auth.

3-275. Biggar, J. W., and D. R. Nielsen. DIFFUSION EFFECTS IN MISCIBLE DISPLACEMENT OCCURRING IN SATURATED AND UNSATURATED POROUS MATERIALS: Jour. Geophys. Research, v. 65, no. 9, p. 2887-2895, sec., 7 graphs, Sept. 1960, 16 refs.

Miscible displacement has been studied in several porous materials, saturated and unsaturated, at different average flow velocities. The tracer appeared at the end of the soil column well in advance of what would have been expected had no mixing occurred at the boundary of the tracer and tracer-free water. Physical differences between porous materials were manifested by changes in shape and position of breakthrough curves due to ionic diffusion. One of the more important physical features was the magnitude of the volume of water not readily displaced at saturation and its increase when the soil was desaturated. Because the total flux of water moving through field soils is generally small, the role of hydrodynamic dispersion and diffusion in transporting dissolved solutes must be included in the theory of most soil-water processes.--Auth.

3-276. Rowe, P. P. AN EQUATION FOR ESTIMATING TRANSMISSIBILITY AND COEFFICIENT OF STORAGE FROM RIVER-LEVEL FLUCTUATIONS: Jour. Geophys. Research, v. 65, no. 10, p. 3419-3424, diag., 6 tables, Oct. 1960, 2 refs.

An equation was derived from which transmissibility and coefficient of storage of an aquifer can be estimated. A linear change with time of the depth of a nearby surface body of water was assumed in the derivation.

A laboratory model was used to test the applicability of the equation under the conditions assumed in the derivation. The values of T/S calculated from this equation were compared with the value of T/S estimated from data obtained under steady-state conditions. The agreement between these values was fair. The equation seems to be accurate when the boundary conditions are satisfied.--Auth.

3-277. Glover, Robert E., and Morton W. Bittinger. DRAWDOWN DUE TO PUMPING FROM AN UNCONFINED AQUIFER: Am. Soc. Civil Engineers, Irrigation & Drainage Div., Jour., v. 86, no. IR3, pt. 1, p. 63-70, diag., 2 tables, Sept. 1960, 6 refs.

First approximation treatments of the drawdown pattern about a pumped well in an unconfined aquifer are commonly based upon the simplifying assumption that the drawdown does not alter the transmissibility of the aquifer. A second approximation is developed in this paper which accounts for the reduction of the

transmissibility by the drawdown. The first approximate solution can be plotted as a single line on a graph having the dimensionless parameters $y/(Q/2\pi K D)$ and $r/\sqrt{4\alpha t}$ as ordinate and abscissa. The improved solution plots as a series of lines on such a graph. These lines are identified by the parameter $(Q/2\pi K D^2)$. The method of using the graph is the same as before but it is now possible to add a family of curves indicating the ratio of the drawdown to the original depth.--Auth.

3-278. Hantush, Mahdi S. MODIFICATION OF THE THEORY OF LEAKY AQUIFERS: Jour. Geophys. Research, v. 65, no. 11, p. 3713-3725, 2 diags., 7 graphs, table, Nov. 1960, 16 refs.

The theory of leaky aquifers as currently known involves among other things the assumption that the storage in the semipervious layers is small and may therefore be neglected. Frequently, however, the semipervious beds, although of very low permeabilities, may yield significant amounts of water from storage. The present paper deals with flow systems in which the storage in the semiconfining layers is taken into consideration. The more general solutions thus obtained describe the actual flow system more exactly.--Auth.

3-279. Hantush, Mahdi S., and C. E. Jacob. FLOW TO AN ECCENTRIC WELL IN A LEAKY CIRCULAR AQUIFER: Jour. Geophys. Research, v. 65, no. 10, p. 3425-3431, diag., 2 graphs, Oct. 1960, 7 refs.

Solutions are obtained for both steady and non-steady flow to a well eccentrically placed in a leaky circular aquifer. Two external boundary conditions are considered: constant head and zero flux. The well is idealized mathematically as a sink. The relationship between specific capacity and eccentricity is shown graphically for one set of parameters and compared with the same relationship for non-leaky aquifers.--Auth.

3-280. de Josselin de Jong, G. SINGULARITY DISTRIBUTIONS FOR THE ANALYSIS OF MULTIPLE-FLUID FLOW THROUGH POROUS MEDIA: Jour. Geophys. Research, v. 65, no. 11, p. 3739-3758, 2 illus., 13 diags., Nov. 1960, 19 refs.

In Pt. 1 the simultaneous flow of fluids of different properties is treated by substituting these fluids by one hypothetical fluid and applying singularities at those points where the properties of the actual fluids change. Their magnitude is chosen so that the specific discharges in the hypothetical fluid are everywhere identical to the specific discharges in the actual fluids. The flow in the hypothetical fluid can be determined by potential theory from the transformed boundary conditions and the influence of the singularities.

For the determination of the discharge a stream function is used which contains singularities in the form of vortices. For the determination of the fluid pressures a multiple-fluid potential is defined which contains singularities in the form of source and sink distributions. The stream and the potential functions each combine with auxiliary, many-valued functions to form complex potentials. These permit solutions in the form of one integral in complex variables, valid for any point in the entire field, irrespective of the fluid present. The solution for the transition zone between fluids as well as the abrupt interface

is elaborated.

In Pt. 2 the 2-dimensional example of an infinite, confined aquifer with an initial vertical interface between 2 fluids of different specific weight is elaborated, giving as a result the movement of the fluids in the entire field at the first moment and a first approximation for the rotation of the interface around the center as a function of time.

These results are verified by a parallel plate model and an electric resistance model. In the latter model the vortices are replaced by sources for the tracing of streamlines and by source-sink combinations forming doublets for the potential lines.
-- Auth.

3-281. Stankevich, E. F. GROUND WATER OF THE CALCIUM CHLORIDE TYPE WITH AN INCREASED CaSO_4 CONTENT IN THE URALS-VOLGA REGION: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 13-15, table, Jan.-Feb. 1959, pub. Apr. 1960, 2 refs.

The solubility of CaSO_4 in natural waters increases with increasing concentrations of NaCl and MgCl_2 but decreases in the presence of excess H_2SO_4 , MgSO_4 , and especially CaCl_2 . Desulfatization of natural waters can occur when they come in contact with CaCl_2 waters. However, a number of CaCl_2 waters are noted which contain CaSO_4 in concentrations well in excess of its calculated solubility. The reason for the stability of the high CaSO_4 content of these waters is not clear.--F. Manheim.

3-282. Ball, Donald G., and Robert L. Nichols. SALINE LAKES AND DRILL-HOLE BRINES, McMURDO SOUND, ANTARCTICA: Geol. Soc. America, Bull., v. 71, no. 11, p. 1703-1707, diag., graph, Nov. 1960, 2 refs.

A 50-ft. hole was drilled in bed rock at Marble Point, McMurdo Sound. Although the bottom of the hole was -30F., several inches of brine were found there. It had moved down joints and into the drill hole from an intermittent saline lake.--Auth.

3-283. Muir, K. S., and others. WATER LEVELS IN OBSERVATION WELLS IN SANTA BARBARA COUNTY, CALIFORNIA, IN 1959: 46 p., 7 maps, 2 graphs, table, [Menlo Park, California?], U.S. Geological Survey, Sept. 1960, 7 refs.

Investigation of the ground-water resources of Santa Barbara County was continued in 1959 by the U.S. Geological Survey in cooperation with the Santa Barbara County Water Agency. Monthly water-level measurements were made in 203 wells. Precipitation was below average during the water year ending Sept. 30, 1959, resulting in over-all water level decline and ground-water depletion during the year. Fluctuations in water level are reported separately for the Carpinteria basin, Goleta basin, Santa Ynez River valley, San Antonio Creek valley, Santa Maria Valley, and Cuyama Valley.--M. Russell.

3-284. Newcome, Roy, Jr. GROUND-WATER RESOURCES OF THE RED RIVER VALLEY ALLUVIUM IN LOUISIANA: Louisiana, Geol. Survey, Water Resources Pamph. no. 7, 21 p., 9 figs. incl. illus., map, graphs, 5 fold. pls. (maps and cross-secs.), 3 tables (2 fold.), Apr. 1960, 12 refs.

Alluvial deposits in the Red River valley constitute

a relatively undeveloped but potentially important aquifer in northwestern Louisiana. The alluvium is 75 to 150 ft. thick in the thalweg of the entrenched valley. It consists of clay, silt, sand, and gravel; the sand and gravel constitute the lower half of the deposits.

The aquifer is recharged by downward seepage of rainfall in the valley area and by leakage of water from underlying formations of Tertiary age that are connected hydraulically with the alluvium. The aquifer also is connected hydraulically with the Red River and its major tributaries. Ground water in the alluvium moves primarily toward the streams and secondarily down the valley. Water levels fluctuate seasonally.

A few wells have been installed for irrigation. Their yields range from 200 to 1,700 g. p. m. (gallons per minute). Specific capacities that range from less than 10 to nearly 60 g. p. m. per ft. of draw-down have been measured. The results of 7 aquifer tests indicate that ground water is under artesian pressure in the alluvium. General field permeabilities that ranged between 1,000 and 2,00 g. p. d. per sq. ft. were determined from the tests.

The quality of the water restricts its use. The average hardness is 500 p. p. m. (parts per million) and the average Fe content is 6 p. p. m. Chloride concentrations are low, except where salty water from underlying formations infiltrates the alluvium.
-- Auth.

3-285. Deutsch, Morris, and others. GROUND-WATER HYDROLOGY AND GLACIAL GEOLOGY OF THE KALAMAZOO AREA, MICHIGAN: Michigan, Geol. Survey Div., Prog. Rept. no. 23, 122 p., 21 figs. incl. maps, diags., graphs, profiles, 6 tables, 1960, 25 refs.

The Kalamazoo report area includes about 150 sq. mi. of Kalamazoo County. The area is principally one of industry and commerce, although agriculture also is of considerable importance. It has a moderate and humid climate and lies within the Lake Michigan "snow belt." Precipitation averages about 35 in. per year. Snowfall averages about 55 in.

The surface features of the area were formed during and since the glacial epoch and are classified as outwash plain, morainal highlands, and glaciated channels or drainageways. The area is formed largely on the remnants of an extensive outwash plain, which is breached by the Kalamazoo River in the northeastern part and is dissected elsewhere by several small tributaries to the river. Most of the land drained by these tributaries lies within the report area. A small portion of the southern part drains to the St. Joseph River.

The Coldwater shale, which underlies the glacial deposits throughout the area, and the deeper bedrock formations are not tapped for water by wells, and they have little or no potential for future development.

Deposits of glacial drift, which are the source of water to all the wells in the area, have considerable potential for future development. These deposits range in thickness from about 40 ft. along the Kalamazoo River to 350 ft. where valleys were eroded in the bedrock surface. Permeable outwash and channel deposits are the sources of water for wells of large capacity. The moraines are formed dominantly by till of lower permeability, which generally yields small supplies of water, but included sand and gravel beds of higher permeability yield larger supplies locally.

The aquifers of the Kalamazoo area are recharged

y infiltration of rainfall and snowmelt and by infiltration of surface waters induced by pumping of wells near the surface sources. Water pumped from most of the municipal well fields is replenished in part by such induced infiltration. Many of the industrial wells along the Kalamazoo River and Portage Creek are recharged in part from these streams. Locally, however, recharge from the streams is impeded, as their bottoms have become partly sealed by silt and solid waste matter.

Water levels fluctuate with seasonal and annual changes in precipitation and in response to pumping. Pumpage by the city of Kalamazoo increased from about 300 million gallons in 1880 to 4.6 billion gallons in 1957. Despite the fact that billions of gallons are pumped annually from well fields in the Axtell Creek area, water levels in this vicinity have declined only a few feet, as the discharge from the fields is approximately compensated by recharge from precipitation and surface water. Pumpage of ground water by industry in 1948 was estimated at about 14 billion gallons, but the use of ground water for industrial purposes has since declined.

Aquifer tests indicate that the coefficient of transmissibility of aquifers in the area ranges from as little as 18,000 to as high as 300,000 g.p.d. (gallons per day) per foot, and that ground water occurs under

water-table and artesian conditions.

The ground water is of the calcium magnesium bicarbonate type. It is generally hard to very hard and commonly contains objectionable amounts of Fe. Locally, the water contains appreciable amounts of sulfate. Study of the chemical analyses of waters from the area show that all of the tributaries to the Kalamazoo River are fed primarily by ground-water discharge.--Auth.

3-286. Young, Richard A. GROUND WATER AREAS AND WELL LOGS, CENTRAL SEVIER VALLEY, UTAH: U.S. Geol. Survey, [Repts., Open-File Ser.], 20 p., fold. map, table, Sept. 1960.

A total of 22 test holes were drilled during the course of a study of the structural framework of the central Sevier Valley and its ground-water potential. Ten penetrated material capable of yielding sufficient water for irrigation, 10 penetrated material that could supply water for domestic or stock use, and 2 were unsuccessful as water prospects. Water from some beds was highly mineralized. Topographic and geologic considerations provide the basis for dividing the area into 5 ground-water areas: Circle Valley, Sevier-Sigurd, Aurora-Redmond, Redmond-Gunnison, and Gunnison-Sevier Bridge Reservoir.--M. Russell.

12. MINERAL DEPOSITS

See also: Geologic Maps 3-56, 3-57, 3-61; Areal and Regional Geology 3-65; Structural Geology 3-96.

3-287. Lure, A.M. THE PROBLEM OF THE GENESIS OF BARITES OF THE SUMSAR ZINC-LEAD DEPOSIT: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 16-19, graph, table, Jan.-Feb. 1959, pub. Apr. 1960, 16 refs.

The relationships and behavior of Sr and Ba are traced through a number of sedimentary environments in an attempt to clarify the origin of the barites in the Sumsar Zn-Pb deposit.

In rocks of the Sumsar region Ba is enriched in polymict sandstones and argillites while it is increasingly impoverished in marls, limestones, and anhydrites. Sr is enriched in the limestones and anhydrites and is low in the argillites and dolomites.

Since the 2 elements tend to become increasingly separated under surface conditions the high (to 10.8%) concentrations of SrSO_4 in the barites of the Sumsar ore-bearing dolomite horizon lead to the conclusion that they cannot be of sedimentary origin. It is suggested that the Ba and Sr were derived from underlying effusive rocks.--F. Manheim.

3-288. Campbell, William P., Jr. APPALACHIAN GOLD. HANDBOOK AND GUIDE TO GOLD PLACERS OF THE SOUTHEAST: 45 p., 2 maps, sec., 5 diags., The Author, 503 Gay St., Erwin, Tennessee, 1960, 4 refs.

A compilation for the "rockhound" interested in panning for Au in the placer areas of Virginia, North Carolina, South Carolina, Georgia, and Alabama. Chap. 1 outlines the history of Au mining in the area, Chaps. 2, 3, and 4 review the geologic circumstances of Au occurrence and concentration in placers. Chaps. 5 and 6 outline the techniques of placer mining by individual prospectors; subheads include panning, gold rockers, and sluicing. Appendices include

locality lists, bibliography, desirable equipment, and placer classification.--M. Russell.

3-289. Bradbury, J.C. A STRUCTURAL ANALYSIS OF THE NORTHWESTERN ILLINOIS ZINC-LEAD DISTRICT: Illinois State Acad. Sci., Trans., v. 53, no. 1/2, p. 20-24, map, diag., 1960, 3 refs.

The ore deposits of the northwestern Illinois Zn-Pb district occur in 1) fracture zones associated with shallow synclines and basins, and 2) joints that have no direct relation to the folded structure. Nevertheless, studies of surface and underground have indicated that all the ore-bearing structures can be related to a single compressive force, oriented in a NW.-SE. direction.--Auth.

3-290. MacKevett, E.M., Jr. GEOLOGY AND ORE DEPOSITS OF THE KERN RIVER URANIUM AREA, CALIFORNIA: U.S. Geol. Survey, Bull. 1087-F, p. 169-222, 4 illus., 7 maps (5 in pocket), 2 diags., 9 tables, 1960, 35 refs.

In the Kern River U area, an area of about 30 sq. mi. in northeastern Kern County, small U deposits are erratically distributed along fractures, most of them within the Isabella granodiorite of Miller. The deposits probably are too small and of too low grade to be worth mining on a large scale, but they contain local concentrations of ore. U was first discovered in the area in Jan. 1954 at the Miracle mine. Four shipments of U ore, totaling about 189 tons, were made in 1954 and 1955; 2 were from the Miracle mine and 2 from the Kergon mine. The most valuable shipment was the first one from the Miracle mine, which consisted of 46 tons of ore containing 0.53% U. The other shipments contained, respectively, 0.14%, 0.18%, and 0.16% U.

The principal ore mineral is autunite, but minor amounts of sooty pitchblende, carnotite, and meta-zeunerite have been found. Common gangue miner-

als are scarce or altogether lacking in most of the deposits, and wallrock alteration is generally weak or absent.

Most of the deposits probably formed in low-temperature near-surface environments and are epithermal. Some of the numerous hot springs in the area and nearby may have influenced U deposition. A possible alternative explanation for the origin of some of the deposits is that the U was derived from the Isabella granodiorite. This rock locally contains abnormal amounts of U, and it is conceivable that some U was leached from it and subsequently deposited in fractures.

Minor Au deposits, in both lodes and placers, and small W deposits associated with quartz veins or disseminated in tactite also occur in the area.--Auth.

3-291. Rusinov, L.A. STRUCTURAL-TECTONIC CLASSIFICATION OF PHOSPHORITE DEPOSITS: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 102-104, table, Jan.-Feb. 1959, pub. Apr. 1960, 2 refs.

The type of origin of phosphorite deposits is frequently reflected in their characteristics and commercial value. Geosynclinal phosphorites are often associated with volcanic-siliceous formations and occur in large volumes of relatively high grade (27-31% P_2O_5). Deposits on old platforms are frequently associated with glauconitic formations, are thin-bedded, and often distributed over huge areas. Commercial phosphorite beds of this variety vary from 7 to 15% P_2O_5 .--F. Manheim.

3-292. Valentine, Grant M. INVENTORY OF WASHINGTON MINERALS. PART I. NONMETALLIC MINERALS. 2d ed., rev. by Marshall T. Huntting: Washington, Div. Mines & Geology, Bull. no. 37, 2 v. (text and maps), 39 maps, 1960, 225 refs.

This complete list of nonmetallic mineral occurrences in Washington gives brief descriptions of deposits of 95 different industrial minerals and rocks. Occurrences are described in each of the state's 39 counties; 42 commodities occur in Okanogan County, 31 in Chelan County, 25 in Ferry County, and 24 in King County. About 2,000 sand and gravel deposits are listed, with deposits in each county. Basalt is found in all but 3 counties in the state, and peat in 28 counties. The locations of all deposits are shown on the 39 maps which comprise v. 2 of the report.--M. T. Huntting.

3-293. Conrad, Stephen G. CRYSTALLINE LIMESTONES OF THE PIEDMONT AND MOUNTAIN REGIONS OF NORTH CAROLINA: North Carolina, Dept. Conserv. & Devel., Div. Mineral Resources, Bull. no. 74, 56 p., 10 maps, 3 secs., tables, 1960, 40 refs.

Crystalline limestones, or marbles, are found in 18 counties in the central and western piedmont and mountain regions of North Carolina. They occur as far E. as Stokes and Forsyth counties, and as far W. and S. as Cherokee County. The bodies of marble in part form elongated areas of considerable size and in part linear groups and isolated lenses of comparatively small size. These areas include several different geologic formations which range in age from Precambrian, the oldest recognized age in the earth's history, to lower Paleozoic(?).

The most extensive marble formation is the Mur-

phy marble. It occurs in a narrow belt of metamorphosed sedimentary rocks that begins just SW. of the Little Tennessee River in the SW. corner of the state and continues SW. across parts of Swain, Graham, Macon, Clay and Cherokee counties. The thickness of the marble formation varies considerably along strike, but its maximum thickness is estimated to be about 500 ft. Both dolomitic and calcitic marbles are present, and the only producer of dimension marble in the state operates a quarry in the Murphy marble in Cherokee County.

In Madison County 4 types of lime-bearing rocks are present. These are: 1) small lenses of coarse crystalline marble associated with Precambrian(?) gneisses and schists, 2) lenticular limestone beds in the Sandsuck formation, 3) the Shady dolomite, and 4) the Honaker limestone. The Shady dolomite was extensively quarried NW. of Hot Springs, but the quarries have been inactive since about 1930.

Small, apparently isolated lenses of white, coarse-grained marble, associated with Precambrian(?) gneisses and schists occur in Macon, Jackson, Ashe, Mitchell and Cleveland counties.

The Brevard belt is a narrow belt of metamorphosed sedimentary rocks which enters North Carolina in Transylvania County and passes northeastward through Henderson and Buncombe counties. White to bluish-gray, dolomitic and calcitic marble is known to occur in this belt from SW. of Rosman, in Transylvania County, to NE. of Fletcher in Buncombe County.

Two types of lime-bearing rocks are present in McDowell County. The first, and only one that has been of commercial value, is an elongate area of Shady dolomite which occurs along the North Fork of the Catawba River in the northern part of the county. The other is a series of disconnected outcrops of siliceous marble that occurs along the Catawba River between Greenlee and the W. end of Lake James.

The Kings Mountain belt, like the Murphy and Brevard belts, is composed of a narrow zone of steeply dipping metamorphosed sedimentary rocks. It extends from just S. of Gaffney, South Carolina, northeastward almost to the Catawba River in North Carolina. The Gaffney marble occurs as discontinuous beds, or lenses, for the entire length of the belt. It ranges in thickness from less than 50 ft. to about 800 ft. and is predominantly a fine-grained, dark bluish-gray to white, schistose marble. The Superior Stone Company operates the largest crushed limestone quarry in the state at Kings Mountain.

In Stokes, Yadkin and Forsyth counties 2 types of marble are present. One is a white to dark blue, fine-grained, high Ca to dolomitic marble that is very similar to that in the Kings Mountain and Brevard belts. It occurs in a series of outcrops that begin S. of Enon in Yadkin County and continues across Forsyth County through Vienna almost to the Stokes County line near Germantown. The other is predominantly a whitish, coarsely crystalline marble that occurs interbedded with mica schist and quartzite. The outcrops of this marble are found in Yadkin and Stokes counties, but do not form a conspicuous pattern as does the other type.--Auth.

3-294. Thomson, Robert. PRELIMINARY REPORT ON BUCKE TOWNSHIP, DISTRICT OF TIMISKAMING, DESCRIPTION OF MINING PROPERTIES: Ontario, Dept. Mines, Prelim. Rept. [unnumbered], 154 p., provisional maps P-66, P-67, P-67A (separate), scale 1 in. to 400 ft., 7 tables, Nov. 1960, refs.

This mimeographed report is issued particularly to provide information on the properties shown on the accompanying provisional maps but descriptions of all properties in the township are included.

The southeastern part of Bucke is part of the Cobalt camp and contains important Ag-Co deposits. Although prospecting and exploration continue, no producing mine is presently in operation. The Agaunico mine suspended underground work in Aug. 1960.

Although most of the prospecting effort in the township has been in search for metallic deposits, nonmetallic ones are also of interest. Sand and gravel are available for local needs, and Paleozoic limestone is presently being quarried in a small way at the Farr quarry.

In this report the order in which the properties are described is that of position; starting in the NW. corner of the township, lot 1, concession VI is described; this is followed by lot 2, lot 3, etc. Concession V, IV etc. are treated in a similar manner. --From auth. introd.

3-295. Steven, Thomas A., and James C. Ratte. **GEOLOGY AND ORE DEPOSITS OF THE SUMMITVILLE DISTRICT, SAN JUAN MOUNTAINS, COLORADO**: U.S. Geol. Survey, Prof. Paper 343, 70 p., 16 illus., 6 maps (4 in pocket incl. 3 col. geol. maps, scales 1:1,200, 1:12,000, and 1:48,000), 8 diag., graphs (in pocket), 7 tables, 1960, 46 refs.

The Summitville district, in the eastern San Juan Mountains has produced about \$7 1/2 million worth of metals; most of this has been from Au, with lesser amounts in Ag, Cu, and Pb. Cu has been a minor by-product during several periods of mining at Summitville, and since 1940 Cu has averaged between 1 and 5% of the annual production value for those years the mines were operating.

All the rocks that crop out in the Summitville district are of volcanic or related shallow intrusive origin. The oldest rocks near Summitville belong to the Conejos formation of the Potosi volcanic series of middle or late Tertiary age; some remnants of younger quartz latite and rhyolite units of the Potosi series are near the western margin of the Summitville district, but these were not studied in detail during the present investigation. The Conejos formation near Summitville is made up largely of a thick sequence of dark, fine-grained porphyritic rhyodacitic flows. This sequence is cut by a large quartz monzonitic stock along Alamosa Creek S. of the district, and by a smaller stock of similar rock along Wightman Fork E. of the district.

The Fisher quartz latite lies on an irregular erosion surface cut on the older formations. The first eruptions onto this surface were of viscous rhyodacitic lavas which built up a complex heap of volcanic domes, thick local flows, and associated breccias and tuffs. These are cut by 2 bodies of intrusive rock of similar composition and aspect. The rhyodacitic lavas were followed, apparently without significant time lapse, by eruptions of similar bodies of quartz latitic lavas, and by the intrusion of related quartz latite dikes.

Volcanic eruptions were renewed in later Fisher time, following a period of solfataric activity and erosion, and a series of quartz latite flows spread laterally down radial valleys that had been cut on the earlier Fisher lavas.

A few younger volcanic necks are in the general vicinity of Summitville; these are the only remnants of volcanoes formed during the Hinsdale period of volcanic activity. None of these were studied in detail.

A northwestward-trending fault extends diagonally across the Summitville district. The first major movement followed eruption of the lower member of the Fisher quartz latite and preceded the period of hydrothermal activity that altered large volumes of the older Fisher rocks. The fault was reactivated in the northwestern part of the district after some lavas of the upper member of the Fisher quartz-latite were erupted. Subsequent volcanic activity resulted in the injection of dikes along the fault zone, and in the drilling of a volcanic vent along one branch of the fault.

Two periods of hydrothermal activity altered large masses of rock in the general Summitville region. The earlier of these periods was late in the Conejos period of vulcanism, and apparently was related to the intrusion of the quartz monzonitic stock along the southern margin of the Summitville district. Unaltered lavas in the lower member of the Fisher rest unconformably on these altered rocks. Most of the rocks altered during Conejos time are outside of the area studied in detail during the present investigation.

The younger period of hydrothermal activity followed eruption of the lower member of the Fisher quartz latite. The largest mass of rocks altered during this period occupies an area of about 1 1/3 sq. mi. in the central part of the Summitville district, and local variations in the concentration of the different secondary products suggest that the alteration took place with respect to several centers of hydrothermal activity. A northern lobe, containing all of the productive mines in the district, is centered on the NE. face of South Mountain. The more intensely altered rocks here consist of resistant pipes and veinlike masses of vuggy quartz and quartz-alunite rock that commonly contain economic concentrations of Au, Ag, and Cu. The ore minerals, largely pyrite, and enargite but also including local barite, galena, sphalerite, and native S, are generally concentrated in the more porous rocks. The resistant veins are commonly surrounded by irregular envelopes of soft, highly argillized ground. Illite and montmorillonite are the most common alteration products in the argillized envelopes, but locally the inner parts of the envelopes contain abundant kaolinite. The bulk of the altered rocks away from the intensely altered quartz-alunite bodies and their clayey envelopes consist of slightly to moderately altered rocks in which the matrix and ferromagnesian crystals have been largely altered to montmorillonite, quartz, and chlorite, but the plagioclase, sanidine, and quartz phenocrysts are still fresh.

The highly silicified and mineralized veins, and the surrounding argillic envelopes are typical of rocks altered by acid-sulfate solutions, whereas the montmorillonitic and chloritic rocks adjacent to the more highly altered zones are more characteristic products of weakly acidic, neutral, or alkalic conditions of origin. These zonal relations suggest that the altered rocks now exposed at Summitville were formed by a virtually continuous process. Near the original channelways, the rock was leached of its more soluble materials, leaving little more than a porous skeleton of fine-grained quartz. As the acid solutions were progressively neutralized and enriched in soluble bases, alunite as well as quartz formed by the breakdown of the original silicate minerals. Owing to continued neutralization and enrichment in leached bases, the solutions formed first the kaolinitic rocks in the inner part of some of the argillic envelopes, and then formed the illitic rocks comprising most of these envelopes. The acid-sul-

fate solutions apparently were neutralized or nearly neutralized within the argillic envelopes, and the surrounding montmorillonitic and chloritic rocks were formed under nearly neutral or alkalic conditions as the solutions were dissipated outward from the main channels of solution access.

Deposition of the ores was consistently late in the sequence of rock alteration, and took place under much different conditions of origin. Whereas the host rocks in the intensely altered zones formed in an oxidizing, acidic environment, the ore minerals were deposited subsequent to the most intense silicification and leaching and formed in a generally reducing environment. Complex paragenetic relations are characteristic in the ores, and the local occurrence of hypogene barite and native S indicates that

in places partly oxidizing conditions prevailed at times even during the period of generally reducing conditions that accompanied ore deposition.

Although the veins in the Summitville district are irregular, discontinuous, and difficult to project, company mine maps indicate that most of the known vein zones extend from the surface to the level of the lowest mine workings (the Reynolds level), and that in many places metal concentrations of commercial interest extend to that depth. Lacking knowledge of changes in ore grade or mineralogy with depth, we cannot predict how deep the ore may extend, but similar ore deposits in the Red Mountain district, Colorado, the Goldfield district, Nevada, and other places have bottomed at shallow depths.--Auth.

13. FUELS

See also: Geologic Maps 3-2; Areal and Regional Geology 3-67, 3-74; Stratigraphy 3-103, 3-104, 3-106, 3-116, 3-120; Geophysics 3-176, 3-177, 3-178; Sedimentary Petrology 3-271.

3-296. Pyle, Howard C. A PHILOSOPHY FOR EXPLORATION: Shale Shaker, v. 11, no. 1, p. 9-12, Sept. 1960.

Originally published as GeoScience Abstracts 2-1856.

3-297. Cobb, Howard L. OPERATIONS RESEARCH - A TOOL IN OIL EXPLORATION: Geophysics, v. 25, no. 5, p. 1009-1022, 19 figs. incl. map, sec., graphs, Oct. 1960, 11 refs.

Operations Research is a tool which may be used by the exploration man to help in planning exploration activities and in making decisions. Electronic computers and mechanized data handling may be used in the analyses which are a part of Operations Research. Various types of exploration data which we put on punch cards are readily available for Operations Research studies. Mathematical models of various activities play a large role. They are often built up from data of past experience. Thus, statistics and probability theory are important to the studies. Other techniques commonly associated with Operations Research studies are Linear Programming, Game Theory, Queueing Theory, Monte Carlo, and Search Theory. Operations Research has been defined as quantitative common sense. It is probably the cheapest and one of the more effective of our exploration tools. We use it when we plan optimum control for a geophysical survey. We use it when we analyze the future of a frontier oil province.--Auth.

3-298. Bryant, Harvey L. PRODUCTION WELL LOGGING TECHNIQUES: Geophysics, v. 25, no. 4, p. 905-927, 19 figs. incl. chart, profile, diags., graphs, logs, 2 tables, Aug. 1960, 11 refs.

Production well logging techniques provide information necessary for efficient and economical well production. The various techniques are summarized and grouped into the 3 phases of well production. Temperature logs, radioactive tracer logs, and velocity logs are used to obtain cement tops and indications of cement channeling in well completion work. In well repair work encroaching gas and water may be located by various neutron logging techniques, the temperature log, the flowing fluid

density log, the gamma-gamma log, and the conductivity log. Well evaluation work, including fracture location, injectivity profiles, and productivity profiles can be facilitated by use of radioactive tracer logs and the flowmeter log.

Field examples are presented to demonstrate usage of the many logging techniques. Interesting applications of the flowing neutron log are shown, including multiple gas-oil contact location, gas "coning" and dual completion logging operations. Location of water entry by the flowing fluid density log and the conductivity log are illustrated.

The "Humble" flowmeter is briefly discussed. Future development trends in the field of production well logging conclude the paper.--Auth.

3-299. Weaver, Charles E. POSSIBLE USES OF CLAY MINERALS IN SEARCH FOR OIL: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 9, p. 1505-1518, map, chart, 3 secs., diag., graph, 3 tables, Sept. 1960, 19 refs.

During the last 15 to 20 years, our understanding of the geologic significance of the clay minerals has increased from nearly zero to the point where we can begin to make some practical application of our knowledge. Following is a brief list summarizing our general knowledge.

1) We know the clay mineral composition of most of the formations in the United States.

2) Pre-middle Mississippian clay suites are less complex than those in younger sediments.

3) The composition of clay suites may change drastically over an interval of a few feet or remain nearly constant throughout 5,000 ft. of section.

4) Both source and environmental information can be obtained.

5) Expanded clays are contracted by burial.

6) The clay suites in limestones are as variable as those in shales.

7) Clay minerals in sandstones are more apt to have been altered after deposition than the clays in other rocks.

8) Once the clay mineral distribution pattern is established, reasonable environmental identifications can commonly be made.

9) If the environmental significance of the clay suites can be established by other means, the clay data can be used independently to identify environments near the control area.

10) Clays can best be used for environmental determinations in young sediments where deposition

is relatively slow and environments are materially different.

11) Clay can be used for approximate "time correlation" where bentonite beds or unconformities are present and where there is a change in source material.

12) Relatively minor clay differences can be correlated for 10-50 mi.

In the Upper Mississippian and Lower Pennsylvanian of the Midcontinent, the clay suites reflect the source areas and tectonic history. Many formations in this interval contain distinctive clay suites which can be used for identification. Detailed correlations can be made by making detailed studies.

Both in recent and ancient sediments (shales, limestones, and sandstones) clay mineral suites are related to depositional environments. Clay should be of value in locating the more effective energy barriers. In the recent, both sandstone bars and limestone reefs appear to act as barriers and cause different clay suites to be deposited on the landward and seaward sides. Environmental studies are best made by investigating the whole basin and determining the distribution pattern of the various clay facies.

It has been shown that clays can be used to subdivide formations and to locate formation boundaries more accurately than can be accomplished by other techniques. Regional (1,000-2,000 mi.) clay mineral zones occur in the Lower and Middle Ordovician and the Upper Mississippian. In the Ouachitas, kaolinite can be used to differentiate the geosynclinal and foreland facies. The relative sharpness of the X-ray diffraction peak of illite affords a good measure of the degree of metamorphism in this area.

The available data suggest that there may be some relation between hydrocarbon production and expanded clay minerals. Most of the major producing formations in the United States contain an abundance of expanded clays (montmorillonite, mixed-layer-illite-montmorillonite, and chlorite-montmorillonite). Expanded clays retain their pore water to greater depths of burial than do the other clays. If hydrocarbons are formed at any appreciable depth, the shales containing expanded clays would be the main source of water to carry the hydrocarbons from the shales.

Comparison of clay data and velocity data for Tertiary and Paleozoic shales of similar composition (montmorillonite) indicates that the rate of collapse of the expanded clay layers is related to depth and is independent of time. However, the loss of pore water (as shown by density and velocity data) from shale is closely dependent on time.--Auth.

3-300. Landes, Kenneth K., and others. PETROLEUM RESOURCES IN BASEMENT ROCKS: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 10, p. 1682-1691, 2 maps, 3 secs., Oct. 1960, 36 refs.

About 100 million barrels of oil has been produced so far from basement rocks in Venezuela, California, Kansas, and Morocco. Initial productions have been as high as 17,000 barrels per day. The reservoir in most places is fractured metamorphic and igneous rock. Trapping can be either anticlinal or due to varying permeability. All known basement rock accumulations occur where the basement rock is at a higher elevation than the surrounding flanking sediments. The sedimentary veneer overlying the basement rock may or may not contain oil accumulations. Most basement rock petroleum deposits have been found by accident; the probable reserve in these rocks is of such magnitude that discovery by design should become the rule.--Auth.

3-301. Nagy, Bartholomew, ed. SYMPOSIUM ON THE GEOCHEMISTRY OF PETROLEUM: Geochim. et Cosmochim. Acta, v. 19, no. 4, p. 235-317, illus., Aug. 1960, refs.

The papers published in the present issue of *Geochimica et Cosmochimica Acta* formed a part of The General Petroleum Geochemistry Symposium, which was held on June 4, 1959, during the Fifth World Petroleum Congress, at Fordham University in New York. Summaries of these and other papers were preprinted prior to the symposium [see *GeoScience Abstracts* 2-211 through 2-232] and they were discussed from the floor by the participants who came from approximately 30 different countries.--From Foreword.

The papers in this symposium are abstracted separately below.

3-302. Bader, Richard G., and others. RECOVERY OF DISSOLVED ORGANIC MATTER IN SEA-WATER AND ORGANIC SORPTION BY PARTICULATE MATERIAL: Geochim. et Cosmochim. Acta, v. 19, no. 4, p. 236-243, 2 diagrs., table, Aug. 1960, 19 refs.

A brief discussion on some initial data concerning organic matter dissolved in sea water and its adsorption on particulate material is given. Various methods of isolating dissolved organic matter, its effect on the buffer system and on calcium carbonate solubility are discussed. In addition some data on the fatty acid content of sea water are given. The studies on the sorption of organic material on suspended sedimentary particles indicate a functional relationship of mineralogy and organic type.--Auth.

3-303. Oppenheimer, Carl H. BACTERIAL ACTIVITY IN SEDIMENTS OF SHALLOW MARINE BAYS: Geochim. et Cosmochim. Acta, v. 19, no. 4, p. 244-260, 5 illus., map, chart, 3 diagrs., profile, 4 tables, Aug. 1960, 45 refs.

Complete mineralization of organic matter results from a multitude of complex bacterial activities which must involve more than one species of bacteria. The diverse bacterial activities influence the pH, redox potential, production of gases and their resulting disfiguration of the sediment, concentration of certain elements, precipitation and solution of carbonates, diagenesis of silicates, the production of complex organic compounds such as surface-active agents and many other properties of sediments. The bacterial activities are not constant but proportional to the amount of organic matter, pH, sediment particle size, temperature, sequence of physical changes caused by the bacteria in the sediment, and the sequence of the production of organic by-products during decomposition.--Auth.

3-304. Stevenson, Frank J. SOME ASPECTS OF THE DISTRIBUTION OF BIOCHEMICALS IN GEOLOGIC ENVIRONMENTS: Geochim. et Cosmochim. Acta, v. 19, no. 4, p. 261-271, 2 diagrs., Aug. 1960, 46 refs.

Recent research on the distribution of biochemicals in soil is discussed in relation to the solution of problems in geochemistry. Consideration is given to the factors affecting the preservation of biochemicals in natural deposits. The results of a chromatographic study of the amino acids in soils are given. A new concept is presented concerning the nature of the N in sedimentary and igneous rocks.--Auth.

3-305. Hodgson, Gordon W., and others. PETROLEUM PIGMENTS FROM RECENT FRESH-WATER SEDIMENTS: *Geochim. et Cosmochim. Acta*, v. 19, no. 4, p. 272-288, 3 diagrs., 10 tables, Aug. 1960, 33 refs.

Pheophytin and other chlorin pigments are common in sediments deposited in fresh and marine environments due to the ready decomposition of the chlorophyll of the seston during deposition of the sediments. Laboratory investigations showed that it was possible to convert pheophytin to a petroleum-type porphyrin metal complex through a chlorin-metal intermediate. Examination of the dark organic gelatinous sediments of an almost stagnant autochthonous lake showed an appreciable content of trace hydrocarbons, in addition to chlorin pigments. Conversion of the chlorin pigments to petroleum-type porphyrins was apparent with increasing depth in the sediments, particularly when definite reducing conditions were established, at a position well below the top of the lake muds. Measurements of the rate of decomposition in the sediments carried out in the range 102-145°C. and at pH 7.3, indicated that rapid decomposition of chlorins at lake-bottom temperatures. Measurements were also made of the rate of formation of Ni complexes of chlorins at 130-160°C. and at pH 3.6-7.3. In general, the rate of formation of the metal complexes was appreciably slower than the decomposition of the chlorins, especially when the availability of Ni was definitely limited. The instability of the chlorin pigments may account for the low pigment of hydrocarbon ratio of crude oils relative to that of the initial sediments. The rate studies and the observation of petroleum-type porphyrins in lake sediments indicate the formation of petroleum pigments very early in the development of crude oil. --Auth.

3-306. Nagy, Bartholomew. REVIEW OF THE CHROMATOGRAPHIC "PLATE" THEORY WITH REFERENCE TO FLUID FLOW IN ROCKS AND SEDIMENTS: *Geochim. et Cosmochim. Acta*, v. 19, no. 4, p. 289-296, diag., Aug. 1960, 12 refs.

The classical theories of Martin and Synge are used to demonstrate the possibility of chromatographic flow in sedimentary rocks. A simple experiment is described which defines some of the limits of chromatography in quartz sand and in aqueous media. --Auth.

3-307. Breger, Irving A. DIAGENESIS OF METABOLITES AND A DISCUSSION OF THE ORIGIN OF PETROLEUM HYDROCARBONS: *Geochim. et Cosmochim. Acta*, v. 19, no. 4, p. 297-308, diagrs., Aug. 1960, 15 refs.

Proteins and carbohydrates are rapidly degraded to compounds of no direct interest in the problem of the origin of petroleum. Lignin, if carried into marine basins in the form of humic substances, is probably the major progenitor of kerogen rather than the precursor of petroleum. Pigments are but minor contributors to petroleum.

The fate of fatty acids in a marine environment is not completely understood. Although they may not be directly decarboxylated biochemically, it is shown how they can be converted into oxygenated or dehydrogenated acids more reactive than the parent compounds. Illustrations are also given for Diels-Alder reactions that could account for the formation from these compounds of the alicyclic and aromatic hydrocarbons in petroleum.

It is most likely that crude oil is generated in sediments containing concentrations of lipids, the character of which governs the nature of the oil that is formed.--Auth.

3-308. Baker, E.G. A HYPOTHESIS CONCERNING THE ACCUMULATION OF SEDIMENT HYDROCARBONS TO FORM CRUDE OIL: *Geochim. et Cosmochim. Acta*, v. 19, no. 4, p. 309-317, graph, 2 tables, Aug. 1960, 19 refs.

Small amounts of hydrocarbons, similar to those present in petroleum, are known to be dispersed throughout Recent marine sediments. However, their importance as major constituents of crude oils, if present in a like manner in ancient sediments at the time of deposition, is still being debated. Only recently has the significance of the Recent sediment hydrocarbons been indicated by the demonstration that crude oils and the sediments being deposited today contain certain identical kinds of hydrocarbons.

From an awareness of this close relationship and from a knowledge of the distributional differences which exist between Recent sediment and crude oil hydrocarbons, the process of forming oil appears mainly to be a physical one. Consequently, no extensive chemical alterations would be required by this hypothesis.

A study of hydrocarbon solubility in dilute colloidal electrolyte solutions suggested the nature of the physical process by which sediment hydrocarbons may be selectively removed from the source sediments and deposited in the correct proportions to form crude oil. The process appears to involve the solution, migration, and release of hydrocarbons in waters containing natural solubilizers.

The similarity between the relative abundance of certain hydrocarbons in crude oil and the relative solubility of the same hydrocarbons in colloidal electrolyte solutions provides presumptive evidence that crude oils consist of Recent sediment hydrocarbons that were once solubilized in formation waters. --Auth.

3-309. Picard, M. Dane. GEOLOGY OF PENNSYLVANIAN GAS IN FOUR CORNERS REGION. With Sections by Boyd R. Brown, A.J. Loleit, and J.W. Parker: *Am. Assoc. Petroleum Geologists, Bull.*, v. 44, no. 9, p. 1541-1569, 4 maps, 8 secs., 2 tables, Sept. 1960, 36 refs.

Pennsylvanian accumulations of gas and casing-head gas in the Four Corners region (junction of Utah, Colorado, New Mexico, and Arizona) occur in carbonates of Des Moinesian age in 4 lithologic zones of the Paradox member of the Hermosa formation. These zones, from oldest to youngest, have been named Barker Creek, Akah, Desert Creek, and Ismay. They are shelf counterparts of basinal evaporitic sequences.

Reservoir beds are calcirudite, calcarenite, and sparsely to moderately fossiliferous carbonate, which is nearly in place and was deposited in biostromal and biohermal complexes. Dolomitization and other diagenetic changes have affected these units. Vuggy and intercrystalline porosity is predominant; fracturing is important in some places.

In only a few instances can the type of trap, with fair assurance, be defined from present subsurface control. Structurally, all of the gas fields are on surface or subsurface highs of varying relief and areal extent. Sedimentary compaction has contributed to this relief in some places, and late Penn-

Permian-Permian warping has occurred. Most of the present structural relief of these structures is due to folding during the Laramide orogeny. Stratigraphic variations, from porous reservoir beds to nonporous units, contribute to most accumulations and are the controlling factor in some. Even gas and 5 casing-head gas fields have been found, but these are still largely undeveloped with respect to gas. The cumulative gas production to April 1, 1959, in the Aneth complex was 9,682,004 MCF. In April 1, 1959, the cumulative production from the Aneth zone was 179,825,593 MCF at the Barker Creek field, representing slightly more than half of the estimated original recoverable reserves of 315 billion cu. ft. of gas at Barker Creek. These Pennsylvanian gas accumulations seem to be essentially *in situ* occurrences. The source beds are believed to be present in each zone; migration is predominantly local, not exceeding a few miles; entrapment occurred in laterally adjacent areas of clastics and sparsely to moderately fossiliferous carbonates. After initial entrapment, some later re-entrapment probably occurred in places.--Auth.

3-310. Branen, Clifford B. Jr., and Louise M. RECENT EXPLORATION IN THE ARKOMAN AND OUACHITA PROVINCE, SOUTHEASTERN OKLAHOMA: Oklahoma Geology Notes, v. 20, no. 140-147, fig., June 1960, 12 refs.

With increased demand for and value of natural gas reserves, this area has come to the forefront of exploration in the 1959-1960 period. The first significant deep gas production was discovered in Moore County in 1930 from basal Atokan sandstone, and the Spiro sand. The second indication of major reserves came in 1952 in Haskell County from the Cromwell (Morrowan) strata. Lack of a market outlet deterred exploration in the Arkoma basin until 1959, when the drilling of the Midwest Oil Corp. and Frankfurt Oil Co. No. 1 created an intensive leasing campaign. Prices rose and most of the basin is now under lease. The Midwest well revealed several points of geologic importance, among which is the possibility that the structure is only coincident to production. Lack of control to deeper zones indicates geologists have a lot to learn.

The second well of significance in 1959, the No. 1, was drilled by the Sinclair Oil & Gas Co. in northern Latimer County, S. of the Choctaw fault in the Ouachita Mountains. Because of intense folding and repetition of beds, the geology of the Ouachitas is difficult to interpret at the surface; in the subsurface, with drill cuttings as the evidence of rock strata, problems of interpretation are multiplied. The geology of the Arkansas portion of the mountains is so simple and its detailed study should solve some of the problems existing in the Oklahoma portion.--N.C. Murphy.

3-311. Barby, Boardman G. GAS RESERVE POTENTIAL OF THE MORROWSAND, LIGHT FIELD, BEAVER COUNTY, OKLAHOMA: Shale Shaker, v. 10, no. 10, p. 9-16, 4 maps, sec., graph, 2 tables, June 1960, 1 ref.

Exploration for Morrow sand [Pennsylvanian] gas reserves in the Oklahoma Panhandle the last 10 years has been hampered by the lack of reservoir data. In 1958, no pipeline connections were available, and many wells were drilled due to lease expiration rather than justification of economic reserves.

The Light field in NW, Beaver County, producing primarily from the Morrow sand did secure an early pipeline connection. The Morrow thickness in the field ranges from 260 to 351 ft., and there are 2 separate sand units present. The upper is referred to as the Purdy sand and the lower as the Mocane sand. Graphs were prepared on 12 wells in the field producing from the Purdy sand, using cumulative production and surface shut-in pressures. The average open flow potential per well in 1954 was 35 MMCF. Most of the wells exhibited a straight line decline curve on production and had produced an average of 4,747 MMCF gas per well to Apr. 1, 1959. On the basis of projected curves the wells will produce an average cumulative of 6,125 MMCF per well before depletion. A total of 123,710 acre ft. of net productive section underlies the 12 wells. The Purdy zone is expected to contain a total of 73,500 MMCF of recoverable gas; therefore, the recovery factor of the Purdy sand for this field will be 594 MCF per acre ft.

It can be concluded from the study of the Light field that wells completed in the Morrow sand with high permeabilities can have accurate total recoveries projected from production pressure graphs early in the life of the individual well.--C.E. Branham.

3-312. SEEK OKAY FOR BIG TAR SANDS PROJECT: Petroleum Week, v. 10, no. 22, p. 25, 28, map, June 3, 1960.

The Alberta Oil and Gas Conservation Board met in June 1960 to consider a \$110-million proposal for commercial development of Athabasca tar sands. The application is by Great Canadian Oil Sands, Ltd., whose plans call for production of 31,500 barrels per day of 24-gravity crude at an average cost of \$1.82 per barrel. The total bitumen content of the "better grade" sands in this project area is estimated to be 900-million barrels. The tar-sand-derived crude will travel through a 290-mi. pipeline to Edmonton, where it will be bought by Sun Oil Company and Canadian Oil Companies, Ltd. This is a separate project from the \$3.5-million pilot plant in tar sands in the Mildred Lake area operated by Imperial Oil, Richfield Oil (Los Angeles), Cities Service Athabasca, and Royalite Oil.--C.C. McFall.

3-313. U.S. CRUDE POTENTIAL 90-BILLION BARRELS: Petroleum Week, v. 10, no. 24, p. 32, 34, June 17, 1960.

The Interstate Oil Compact Commission's latest estimate of producible crude from known fields in the U.S. is 89.8-billion barrels, 11.6-billion barrels more than its 1958 calculation. Most of the increase in the 1960 estimate reflects IOCC's decision to give credit, for the first time, to recovery that can be anticipated from such later-day methods as solvents and thermal processes. In round figures, it was estimated that 45.7-billion barrels are economically recoverable by conventional methods, and 44-billion barrels more are physically recoverable with known improved methods. This suggests that 50% of the oil in place will eventually be recovered by presently economical methods.--C.C. McFall.

3-314. Banks, Joseph E. PETROLEUM IN COMANCHE (CRETACEOUS) SECTION, BEND AREA, FLORIDA: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 11, p. 1737-1748, 2 illus., map, 2 charts, 2 graphs, Nov. 1960, 29 refs.

Petroleum occurs in the Comanche section of middle Albian (Trinity) age in the Bend area of southern Florida. Commercial amounts of oil are found in a 430-ft. cyclothem which contains bituminous limestones, porous dolomites, coquina limestones, dense limestones, white anhydrites, and calcareous shales.

These varied and thin-bedded rocks are associated with the Sunniland pay zone at depths near 11,000 ft. In this cyclic sequence petroliferous limestones are found near reservoir limestones and both are confined by dense anhydrite, shale, or limestone.

In the Bend area depositional structures plunge very gently NW. and are tilted NE. which is the reverse of regional dip.--Auth.

3-315. Duren, Jack D. SOME PETROPHYSICAL ASPECTS OF THE MISSISSIPPIAN "CHAT" GLICK FIELD, KIOWA COUNTY, KANSAS: Shale Shaker, v. 11, no. 1, p. 2-8, 6 illus., map, graphs, table, Sept. 1960, ref.

The Glick field is one of several fields forming an arc around the southern end of the central Kansas uplift which produce from the so-called Mississippian "chat." The "chat" (an old oil field term for tripolitic chert) varies in characteristics from field to field in this group but is remarkable in the Glick field for its high porosity, which ranges from 26 to 51%. The chert, because of its porosity, most of which is not visible under the usual means of examination, exhibits some extremely low resistivities on the electric log, plus other unusual petrophysical characteristics.

Investigation by means of core analyses, capillary pressure curves, and thin sections indicate that in this field the permeability-saturation relationship of the chert rather than the porosity-saturation relations governs the productivity. Formation resistivity factors determined in the laboratory gave calculated cementation (m) factors of 2.10 to 2.75, with an average of 2.36. Porosity-saturation relationships were not well defined but tend to show that porosity below 15-20% will be water filled. Free water level, i. e., where capillary pressure is zero, calculations from capillary pressure curves do not agree with production tests and electric log calculations. The reason for this has not been firmly established.--Auth.

3-316. Stipe, Jack C., ed. SALT DOMES OF SOUTH LOUISIANA: 145 p., 67 maps, 5 logs, New Orleans Geological Society, c/o C. H. Woodbury, 800 California Co. Bldg., New Orleans, Louisiana, July 1960.

Salt domes create the most prominent traps for oil and gas accumulation in S. Louisiana, as well as pose many perplexing questions as to their origin and growth. With the exception of a few field papers and several articles speculating on dome genesis, geological literature contains little basic data relative to individual domes, and there has been no prior effort to assemble data which are available for the 112 salt domes in this province.

The New Orleans Geological Society prepared this compilation to assist the petroleum and other mineral industries in their exploration and exploitation and, in a broader sense, to supply the geological profession with the prerequisites for further study of the origin and evolution of salt domes and their basins.

As an initial effort, individual maps and accompanying data sheets have been constructed for 67 salt domes; a supplement covering the remaining 45

domes will be published in the near future to complete this volume.

Unless otherwise noted, the maps are dated Nov. 1, 1959. Generally, structural contours are drawn on the top of the salt; however, in some cases, it was found necessary to map portions of several domes on a cap rock datum. The data sheets are the products of exhaustive search and careful compilation; only in the earlier explored domes are the data incomplete.--From introd.

Information on each salt dome includes: base map with producing and dry holes, contours on top of salt, data on annual and cumulative production of oil and gas, total oil and gas wells, producing zone, deepest section penetrated, principal operators and market outlets.

3-317. Gelpman, Norman Ray. WEST SENTINEL OIL FIELD, WASHITA COUNTY, OKLAHOMA: SEDIMENTOLOGY OF THE "GRANITE WASH" AND STRUCTURAL GEOLOGY: Shale Shaker, v. 10, no. 6, p. 2-16, 4 illus., secs., 6 maps, Feb. 1960, 2 refs.

Normal stratigraphic sequence in this area includes Ordovician, Pennsylvanian, and Permian beds. The Ordovician lithology is mostly limestone and a little sandstone. The Pennsylvanian beds are mostly shale, granite wash, and arkose. Permian rock characteristics are mainly shale, gypsum, anhydrite, and weathered igneous rocks. Mississippian strata were probably once deposited in this area and were later eroded. Fusulinids appear to be the only fossils that can be used with any degree of accuracy in correlating zones.

A major unconformity in this area separates Ordovician beds from Des Moinesian beds. From observation of electric logs and rotary well cuttings the top of the Wellington formation is the most easily recognized horizon in the area under study. Beds of Wellington age dip approximately 225 to 300 ft. per mi., generally northward towards the axis of the Anadarko basin, and beds of upper Virgilian age dip approximately 425 to 475 ft. per mi. northward toward the axis of the Anadarko basin. The general strike of Wellington and Virgilian strata is E.-W.

The pulsations and local uplifts of the Wichita orogeny are reflected by the repetitions of coarse conglomerates and shale beds in this area.

The "granite wash" of the West Sentinel Field is an accumulation of pebbles, arkose, and some shale. The pebbles are clastic limestone or dolomite, chert, and igneous rocks. The matrix of the "granite wash" is mainly poorly sorted arkose loosely cemented by calcium carbonate.

Sandstone percentage of the upper 1,400 ft. of Pennsylvanian beds decreases N. and S. of the producing area and appears to be a strong controlling factor in the boundaries of the field.

The area under study is producing oil and gas from what appears to have been an offshore bar.

The embryonic formation of the high area, which served as a gathering place for sediments that constituted the offshore bar, may have coincided with the beginning of the Wichita orogeny. Uplift in the Wichita Mountains may have continued into Permian time as is evidenced by beds of coarse angular feldspar and quartz sandstone during Wolfcampian time.--C. E. Branham.

3-318. Abilene Geological Society. THE STRATIGRAPHIC DISTRIBUTION OF HYDROCARBON PRODUCTION FROM 12 COUNTIES IN THE ABILENE

EA: [81] p., 78 maps, chart, [Abilene, Texas], 1960.

This study portrays the stratigraphic distribution of the more important oil and gas fields of the Abilene, Texas, area in the following 12 counties: DeWitt, Coke, Coleman, Fisher, Haskell, Jones, Garfield, Runnels, Shackelford, Stonewall, Taylor, and Rockwall. The fields included in this study have produced 50,000 barrels or over, have 5 or more wells, or are considered significant fields (e.g., prolific discoveries, etc.). An index map of each county portraying the producing fields is included with a series of county maps portraying the producing levels designated by system or series boundaries. That portion of the field producing from a given level is indicated in solid "black" within the field outline. Statistical data for each producing zone within a producing level is portrayed in abbreviated form opposite the individual fields. The systems, series, and designated producing zones are based on electric log correlations.--From pref.

19. Haught, Oscar L. OIL AND GAS REPORT ON KANAWHA COUNTY, WEST VIRGINIA: West Virginia Geol. & Econ. Survey, Bull. no. 19, p. 4, 4 maps (1 separate, scale 1:62,500, with columnar sec.), 1960.

A short account of stratigraphy, especially subsurface, down to Precambrian, is followed by history of local development of oil and gas production and descriptions of productive areas in individual magisterial districts. A note on prospects for future development of production from deeper sands, Silurian and Ordovician, concludes this bulletin.--Auth.

20. Haught, Oscar L. OIL AND GAS REPORT ON LEWIS AND GILMER COUNTIES, WEST VIRGINIA: West Virginia Geol. & Econ. Survey, Bull. no. 14 p., illus., 4 maps (1 separate, scale 1:62,500, with columnar sec.), tables, 1960.

A brief discussion of structure and of lithology of exposed and subsurface post-Cambrian rocks, followed by an account of oil and gas development to date and a note on prospects for future successful prospecting.--Auth.

21. Irizarry, O.B. QUE' OFRECE LA TIERRA DEL FUEGO [What Does Tierra del Fuego Offer]: *Petróleo Interamericano*, v. 18, no. 5, p. 36-41, 5 illus., map, sec., 2 tables, May 1960.

Tierra del Fuego, jointly owned by Chile and Argentina, is an archipelago at the tip of South America. It lies in the Cretaceous and Tertiary Magellan basin which covers some 64,000 sq. mi. of southern South America. The basin stratigraphic sequence consists of up to 20,000 ft. of Upper Jurassic to late Tertiary sediments. In Tierra del Fuego the section consists of the Upper Jurassic Springhill formation, marine sands, shales, and marls resting unconformably on igneous basement and overlain conformably by Cretaceous marine shales and siltstones. Tertiary marine marls and shales lie with possible slight disconformity on the Cretaceous and are succeeded by the Palomares clastic formation of possible Pliocene age. Thickness of the Tertiary is about 100 ft. Quaternary glacial deposits cover the island surface. Jurassic Springhill sands produce oil from traps considered to be anticlinal.

Petroleum exploration studies have been pursued

since 1938, 37 wells have been drilled, and 5 oil fields discovered. Tennessee Argentina presently holds exploration rights for Tierra del Fuego.--H. G. Richards.

3-322. Koch, Edwin. MAQUIA: A NEW PRODUCING AREA IN EASTERN PERU: *Petróleo Interamericano*, v. 18, no. 1, p. 42-47, 3 figs., 2 maps, Jan. 1960.

In the area of Contamana, in northern Peru near the Brazilian frontier, oil has recently been discovered in the Lower Cretaceous Agua Caliente and Upper Cretaceous Azucar sandstones. Production is obtained from NW.-SE.-trending anticlines of low structural relief.--H.G. Richards.

3-323. Walters, Ray P. SURANI, ROMANIA, ANTICLINE WITH TWO EROSION-DEPLETED, NON-CONTEMPORANEOUS OIL RESERVOIRS: *Am. Assoc. Petroleum Geologists, Bull.*, v. 44, no. 10, p. 1638-1650, 3 illus., 4 maps, 7 secs., Oct. 1960, 8 refs.

The Surani anticline has 2 formations exposed with sands containing a residue of oil - Meotian of the Pliocene and Kliwa of the Oligocene. These represent oil reservoirs which have been depleted by erosion. The oil sands of the upper reservoir bear a normal relation with the anticline, but those of the lower do not.

The sand series in which the lower reservoir occurs is oil-free along the crest of the anticline at its highest point and down the N. flank, but down the S. flank and down the plunge toward the NE. these sands abruptly are found to contain the oil residue. The break from white "barren" sand to oil sand is along a sharply defined plane. This plane, where it can be seen clearly in a bed dipping 15° S., is inclined 45° to the bedding plane and 60° to the horizontal, with the oil sand on top and on the down-dip side. The plane is thought to represent a former oil-water contact.

These conditions are interpreted to mean that the oil was originally collected in some trap S. of the Surani anticline and furthermore that this reservoir was formed and depleted before the Surani anticline came into existence. This latter event took place in pre-middle Miocene time. The oil sands one sees today were at the N. limit of the reservoir and at the time of depletion were dipping 45° N.

The Surani occurrences are considered as supporting the indigenous origin of the oil in the Pliocene of Rumania.--Auth.

3-324. SOVIETS SEEK MORE OFFSHORE RESERVES: *Petroleum Week*, v. 11, no. 14, p. 20, 21, 4 illus., map, Oct. 7, 1960.

Soviet oil men are intensifying their exploration program in the Caspian Sea in an ambitious drive to revitalize the prestige of the aging Baku fields. Cradle of the Russian oil industry, the Baku area once produced 90% of the country's crude. As recently as 1940, it still accounted for 70% of the daily output - then running about 613,460 barrels per day. Now, the republic of Azerbaijan, in which Baku is located, produces less than 15% of the Soviet Union's total output of 2.9-million barrels per day of crude. Baku oil men fiercely deny that their oil fields are aging into obscurity.

During the current Seven Year Plan, for example, they expect to dedicate fully 40% of their efforts to the deeper waters of the Caspian. They are now

using mobile drilling barges, for the first time.

Azerbaijan scientists claim they have mapped no less than 52 prospective structures beneath the Caspian's waters. They say they have evidence that oil-bearing zones extend all the way across the sea to the Turkmen republic, where only recently exploration crews have begun work from the familiar platforms and trestles.

Only a few weeks ago, the Russians said that exploration efforts in a new offshore area NW. of Neftyanyye Kamni has yielded "splendid results." Neftyanyye Kamni is literally a small city in the sea. It is located 60 mi. offshore from Baku, and is probably the most extensive deep water installation in the world. Development of Neftyanyye Kamni began 12 years ago, but over the last 5 years it has been receiving increasing emphasis. Even though their hopes are bright for the offshore program, Soviet oil men contend the Caspian is the roughest sea faced by drilling and production crews anywhere.--C.C. McFall.

3-325. Tamrazyan, G.P. ON SOME FEATURES OF THE DISTRIBUTION OF OIL AND GAS DEPOSITS IN THE AZERBAIDZHAN S.S.R. AND GAS DEPOSITS IN THE R.S.F.S.R.: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 105-108, 2 maps, Jan.-Feb. 1959, pub. Apr. 1960, 3 refs.

The most important occurrences of oil and gas in Azerbaijan are associated with the Adzhikabul-Mar-dakyan deep fracture. Ninety-seven percent of the past production of Azerbaijan and 79% of the known reserves occur in the belt along this fracture. The gas resources of the Russian Federated Socialist Republic are also largely associated with a 1,600 km. long belt. It is suggested that this linear zone may also reflect deep fractures of the base of the earth's crust.--F. Manheim.

3-326. Alekseev, L.S. MINERAL IMPURITIES IN COAL: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 186-187, Jan.-Feb. 1959, pub. Apr. 1960, 2 refs.

The mineral fraction of Mesozoic coals of the Khabarovsk district was studied. The separation was carried out first by coarse crushing in a ball mill, followed by separation of size fractions greater and less than .01 mm. The mineral fraction was separated from these 2 groups by centrifugation with a liquid of specific gravity 2.0. The minerals were studied by polarizing microscope supplemented by X-ray and differential thermal analysis for the clay fraction. The bulk of the mineral fraction of the coal consists of quartz, feldspar, and clays, chiefly illite and kaolinite. Other materials found include volcanic glass, micas, amphiboles, pyroxenes, carbonates, sulfides, iron oxides, titanium oxides, sulfates, and a group of heavy accessory minerals. The main authigenic minerals are siderite and pyrite. Siderite and pyrite show antipathic tendencies in the coal studied.--F. Manheim.

3-327. Shterenberg, L.E., and others. CHARACTERISTIC FEATURES OF METAMORPHISM OF DIFFERENT TYPES OF HUMIC COAL: Akad. Nauk SSSR, Doklady, Earth Sci. Secs., in English translation, v. 124, no. 1-6, p. 182-185, illus., diag., graph, table, Jan.-Feb. 1959, pub. Apr. 1960, 7 refs.

The molecular structure and elemental composition

of different types of humic coals belonging to the same genetic group is described. It is found that for each rank of coal the vitrain is characterized by a definite degree of order, which is registered on microphotometric tracings of X-ray diffraction photographs. It is concluded that the metamorphism of each individual constituent of dull and bright coals proceeds along an independent line, depending on the genesis of the constituent.--F. Manheim.

3-328. Haley, Boyd R. COAL RESOURCES OF ARKANSAS, 1954: U.S. Geol. Survey, Bull. 1072-J, P, p. 795-831, 7 maps (in pocket), sec., 6 graphs, 10 tables, 1960, 37 refs.

Coal of Pennsylvanian (Des Moines) age underlies approximately 1,700 sq. mi. in the western part of the Arkansas Valley region in W.-central Arkansas. The coal ranges in rank from low-volatile bituminous to semianthracite; the greater part is classed as low-volatile bituminous. Coal produced in this area is mined from the lower and upper Hartshorne coal beds of the McAlester formation and from the Charleston and Paris coal beds of the Savanna formation in Sebastian, Scott, Logan, Franklin, Johnson, and Pope counties. The lower Hartshorne coal beds at the base of the McAlester formation has been the source of most of the coal.

Reserves of coal in the Arkansas Valley coal field are estimated as follows: original reserves 2,272 million short tons; remaining reserves 2,080 million short tons; and recoverable reserves 1,040 million short tons. The estimated original reserves included 1,816 million short tons of low-volatile bituminous coal and 456 million short tons of semianthracite. These summary reserve estimates are subdivided in this report and listed in categories of rank, county, and individual coal bed. The estimates are also qualified in relation to coal-bed thickness, amount and reliability of data, and amount of overburden.

Lignite is present discontinuously in rocks that are exposed over an area of approximately 6,125 sq. mi. in the Gulf Coastal Plain of Arkansas. The lignite-bearing rocks are in the Tokio formation of Cretaceous age, and the Wilcox group, the Claiborne group, and the Jackson formation of Eocene age. The lignite beds are lenticular, and individual beds probably do not extend over an area larger than about 2 sq. mi. The original reserves of lignite in known deposits under less than 100 ft. of overburden are listed by counties in this report and are estimated to be 32 million short tons. The total reserves of lignite in Arkansas are tentatively estimated to be 350 million short tons. The total amount of lignite mined in Arkansas since the beginning of mining probably does not exceed 100 thousand short tons.--Auth.

3-329. Warren, Walter C. RECONNAISSANCE GEOLOGY OF THE BIRNEY-BROADUS COAL FIELD, ROSEBUD AND POWDER RIVER COUNTIES, MONTANA: U.S. Geol. Survey, Bull. 1072-J, p. 561-583, 2 maps (1 under separate cover, scale 1:63,360), 7 sec. (under separate cover), diag., 3 tables, 1959, 7 refs.

The Birney-Broadus coal field covers about 850 sq. mi. in Rosebud and Powder River counties in southeastern Montana. The consolidated sedimentary rocks exposed in the area are about 1,800 to 1,900 ft. thick, are nonmarine, and belong to the Fort Union formation of Paleocene age; the Fort Union formation is divided into the Tongue River member and a

r member. All coal beds that were mapped for
oses of reserve calculation are in the Tongue
r member. The reserves of coal in the area

are estimated to be about 21 1/2 billion short tons,
all of which are within about 1,000 ft. from the sur-
face in beds 2 1/2 ft. or more thick.--Auth.

14. ENGINEERING GEOLOGY

30. Leet, L. Don. VIBRATIONS FROM CON-
DUCTION BLASTING: Explosives Engineer, v.
no. 1, p. 13-19, Jan.-Feb. 1960; no. 2, p. 47-
March-Apr. 1960, 11 illus., 4 tables, 6 refs.

Pt. 1. The process of blasting rock involves a com-
plicated series of steps before and after the blast, and
problems encountered in various types of blasting
variations vary widely. Each of these steps influences
resulting vibrations and the characteristics which
turn their effects on man-made constructions. Size,
depth, spacing of holes; distance from any free rock
face; the location of explosives in the hole; and the quanti-
ty of explosives required to break a specified volume of
rock have an important bearing on the results. The most
general rule is that the arrangement of holes and explo-
sives which produce the most efficient breakage of rock
automatically produces a minimum of vibration.
Choice of explosive is made on the basis of the
properties of explosives and of the rock. Explosives
differ in density, strength, and in the rate at which
they detonate, in their resistance to water, and in
the energy they apply to breaking rock. Their capac-
ity for generating vibrations results from combina-
tions of these factors.

The effectiveness of an explosive in breaking rock
in generating vibrations depends on the total
energy it releases, the rate at which it is released,
the efficiency with which it is transmitted to
surrounding rock. Although these are not controlled
under any single property of the explosive, total energy
is a useful characteristic for rating explosives.
High rate of detonation and high initial pressure are
important in breaking rock. Pressures set up by gases
produced by the explosive exceed the strength of the
rock, thus crushing them. These pressures reduce
quickly to values below the compressive strength of
the rocks. Crushing then stops, and the remaining
energy moves into unbroken rock as a wave of pres-
sure or shock front. Breakage may occur near the
free face when the shock front is reflected back into
the rock as a wave of tension.

In rock in which the charge depth was so great
that no crater was formed there was still cracking
in the shape of a crater outlining a potential crater
zone, or zone where a crater would have formed if
there had been enough explosive. This potential
crater zone has an important relation to effects at
the surface.

In most commercial operations, rupture of rock
by reflected strain pulses, supplemented by work
done by expanding gases is not adequate to explain
the details of breaking. These are governed largely
by features of the rock, chief of which are joints.
Two characteristics of rocks important in deter-
mining their reaction to vibrations from blasting
are their elasticity and characteristic impedance.
Elasticity is measured by the speed, V , with which
elastic waves traverse a rock: $V^2 = \frac{\text{elasticity}}{\text{density}}$. If

density, $dV^2 = \text{elasticity}$. Then $dV = \text{character-}$
istic impedance. The speed of compressional waves
is easily determined. Granite, for example, has V for
compressional waves of 18,200 ft./sec. and its
characteristic impedance is 54 lbs.-sec./in² where-
as the values for shale are 6,400 and 15 respectively.

Breakage of rock and resultant vibrations are
directly related to amount of energy transferred from
explosive to rock and the efficiency with which this
energy is transmitted through the rock. The amount
of energy transferred to a given rock is a linear
function of characteristic impedance of the explosive.
Therefore explosives having a larger impedance
more nearly matching that of the rock, transfer more
energy to the rock.

Pt. 2. In delay detonation the pressure fronts in
rock are effectively separated, so that the work of
breaking the rock and disturbing the unbroken rock
is as a series of closely spaced but independent
events. This improves fragmentation and reduces
the amount of energy carried by vibrations to sur-
rounding territory. The greatest amount of energy
that reaches surrounding ground and buildings from
a delay blast is that released by the most explosive
on any one of the delay intervals.

Only a small fraction of the volume of the hemi-
sphere of rock around a blast is bounded by a free
face close enough to be fractured by a reflection of
the pressure front. Elastic waves derived therefrom
constitute vibrations felt by people in the vicinity
and which sometimes shake structures.

The amount of displacement of the earth's surface
as elastic waves pass is greatest in overburden and
least in rock. Displacement seismographs, such as
the Leet, are used to study these by-product waves
in the ground, especially in their capacity for damag-
ing structures. It records amplitude and frequency
of ground or structure movement. Energy is the
most important factor in vibrations' ability to do dam-
age, and this varies as the square of the frequency
and the amplitude.

The effect of vibrations on structures is governed
by their magnitude and by the way in which they
deliver energy to distant places. The greatest dif-
ferential displacement is between points a half wave
length apart, and it is differential displacement that
causes rupture of materials. If the wave's length is
large relative to the size of the structure, the latter
moves almost as a single unit with little differential
displacement at any point.

Frequency is important in determining the effect
of elastic wave motion on structures. The best guide
to damage-causing possibilities of vibrations is the
energy they possess.

A region called the potential crater zone includes
rock which, if a sufficient quantity of buried explo-
sive were detonated, would be shattered and pro-
jected outward to form a crater. The size of the
crater depends on the kind of explosive, the depth
at which it is buried, and the type of rock. For
many brittle rocks, the diameter of the potential
crater zone is not greatly different from twice the
depth at which the explosive is buried. Fixed safe
limits for permanent displacements depend on each
individual structure and on those parts supported by
the ground thus affected. To assure safety from
effects within the potential crater zone, keep build-
ings and other earth-supported materials such as
pipelines out of it.

An important discovery is that vibrations can be
felt and even seem severe when there is only a

negligible fraction of sizes necessary to do damage. The U. S. Bureau of Mines developed a formula relating maximum displacement by vibrations to quantity of explosive and distance, but the actual amount of motion in the ground depends also on the nature of the terrain at the point in question.

Tunneling through rock involves special procedures in drilling and blasting, and produces unique vibration patterns. It is usually impossible to load sufficient explosives to be fired in sequence to damage structures on the surface without destroying the tunnel itself.--J. W. Skehan.

3-331. Serata, Shosei, and Earnest F. Gloyna. PRINCIPLES OF STRUCTURAL STABILITY OF UNDERGROUND SALT CAVITIES: Jour. Geophys. Research, v. 65, no. 9, p. 2979-2987, 6 figs. incl. diags., graphs, Sept. 1960, 6 refs.

The principles of structural stability of underground salt cavities and the significance of the principles as they relate to other cavities are discussed. The theory of plasticity is applied to the evaluation of stress and strain conditions of the salt cavities. The concept of a yielded zone which develops around the cavities is introduced, and a theoretical development of the extent and stress distribution of the zone is illustrated through the use of ideal spherical and cylindrical cavities under uniform triaxial compression. Applicability of the concept to actual conditions, such as cavity irregularities, brittleness of formation, and nonhydrostatic loading, is discussed.--Auth.

3-332. Aho, Aaro E. GRAPHICAL STATISTICAL ANALYSIS OF FRACTURE PATTERNS IN ROCK ENCOUNTERED IN ENGINEERING PROJECTS: Geol. Soc. America, Bull., v. 71, no. 11, p. 1719-1720, Nov. 1960, 3 refs.

The directional competence of badly fractured rock in engineering foundations can be analyzed by plotting the various types of fractures on a Schmidt equal-area projection and combining the data suitably. Interpretation of the results may increase safety factors and efficiency in grouting, strengthening devices, design, and tunnelling.--Auth.

3-333. U.S. Bureau of Reclamation. EARTH MANUAL. A GUIDE TO THE USE OF SOILS AS FOUNDATIONS AND AS CONSTRUCTION MATERIALS FOR HYDRAULIC STRUCTURES: 751 p., approx. 300 figs. incl. illus., maps, diags., tables, Denver, Colorado, July 1960, refs.

The manual provides current technical information on the field and laboratory investigations and construction control of soils used as foundations and materials for dams, canals, and many other types of structures built for U. S. Bureau of Reclamation projects in the United States. It contains both standardized procedures that have been found desirable for securing uniform results throughout the Bureau and general guidelines intended to assist but not to substitute for engineering judgment.

Chap. 1 describes the Unified Soil Classification System and discusses the various properties of soils relating to engineering uses. Investigations of soils are covered in Chap. 2, which describes the various stages of investigation corresponding to the stages of development of the Bureau projects and gives technical information necessary for planning and executing explorations and for presenting the results.

Chap. 3 presents information on the control of construction from the soils standpoint, for both foundation treatment and compaction control of fills. In addition to a general treatment of the subject applicable to all types of earthwork, separate sections are devoted to problems of rolled earth dams, canals, and miscellaneous construction features. The appendix contains detailed procedures for sampling, classification, and field and laboratory testing of soils. Instructions for installing and obtaining information from instruments that measure pore-water pressures and displacements within and adjacent to earth embankments are also included. A tabulation of conversion factors commonly used in earth construction is included at the end of the appendix. The appendix also contains laboratory test procedures which are used in both the project laboratories and the central Bureau laboratory, and some of the more complex test procedures which are performed only in the central laboratory.--From pref.

3-334. Soward, Kenneth S. GEOLOGY OF DAMSITES ON THE UPPER TRIBUTARIES OF THE COLUMBIA RIVER IN IDAHO AND MONTANA. KNOWLES AND PERMA DAMSITES, LOWER FLATHEAD RIVER, SANDERS COUNTY, MONTANA: U.S. Geol. Survey, Repts., Open-File Ser., no. 588, 57 p., 3 illus., 3 maps (2 in pocket), secs. (in pocket), July 1960, 11 refs.

Knowles and Perma dam sites, at river mi. 3 and 11 respectively, are alternates for developing the lower Flathead River. A high dam with a flow line at altitude 2,705 ft. would back water to Kerr Dam at river mi. 72 and would produce a hydraulic head of 235 ft. at Knowles and 225 at Perma. Low head dams in combination with upstream dams could be used to develop the sites also. Economic studies of both development schemes should be made.

Precambrian metasedimentary rocks including quartzites, impure quartzites, and argillites, of the Prichard formation, Belt series, make up the valley walls. At Knowles the river is flowing along the crest of a gentle anticline. At Perma the river is flowing across the nose of a SE.-plunging asymmetrical fold well outlined by 2 large diorite sills. At both sites the valley bottom is filled with about 255 ft. of interbedded very fine-grained sand, silt, and clay deposited in glacial lakes. Either site is feasible only for an earthfill dam. Additional testing of the unconsolidated valley fill is necessary.

At Knowles dam site a rock knob 800 to 1,600 ft. S. of the right valley wall extends through the valley fill and rises to slightly above 2,650 ft. Either line A-A', which crosses the knob, or B-B', 2,400 ft. upstream, is suitable for a high dam. B-B' has the smaller valley cross section. A-A' has a narrower section underlain by lake beds and offers a wider choice of sites for appurtenant works. A-A' is the best axis for a low dam and most likely for a high dam too.

At Perma dam site sections C-C' and D-D' are possible axes for a dam with a flow line between 2,600 and 2,705 ft. The abutments are in strong rock that would be good foundation sites for the appurtenant structures. At C-C', a wide terrace S. of the river is underlain by 23 to 56 ft. of pervious sand and gravel. Contact between the gravel and underlying lake beds is between altitude 2,444 to 2,480 ft. Two spillway sites are present on D-D': one is across the rock spur forming the right abutment; the other is along an abandoned high level channel of Flathead River that swings 2,200 ft. S. of

left abutment. For a high dam, geological conditions are slightly better at D-D' than at C-C'. B and E-E' are possible axes for a dam with a line between altitudes 2,514 and 2,600 ft. At the axis the foundation and right abutment would be consolidated lake beds. At D-D', the left abutment is the Prichard formation and at E-E' a diorite. The sill would be an excellent foundation for permanent structures. Geologically, E-E' is the axis for a low dam.--W.R. Schriever.

35. Legget, Robert F., and W.R. Schriever. **INVESTIGATIONS FOR CANADA'S FIRST UNDERGROUND RAILWAY:** Natl. Research Council Canada, Div. Bldg. Research, Research Paper no. 818, p. 10 illus., 1960, 5 refs.; reprinted from: *Engineering & Public Works Review*, London, 1965, no. 642, p. 73-80, Jan. 1960.

A brief description of the 4 1/2 mi. long Yonge subway, Toronto, Ontario, is followed by an outline of the local geologic conditions, which are of special interest because of the succession of Pleistocene glacial and interglacial beds. Extensive soil studies undertaken prior to and during the construction of the subway, which was built by the cut-and-cover method, are outlined. Many different soils were encountered, with glacial till and interglacial loess, silts, and sands predominating, and recorded in a continuous soil profile. Some other studies carried out during the construction of the

subway are also mentioned.--W.R. Schriever.

3-336. **REPORT ON SANTA MONICA PALISADES SLIDES:** Southwest Builder & Contractor, v. 135, no. 7, p. 37-43, Feb. 1960.

A concise summary of a report by a committee made up of E.T. Telford, J.W. Trask, J.C. Womack, F.W. Panhorst of the City of Los Angeles, M.M. King of the City of Santa Monica, and J.A. Lambie of the County of Los Angeles. Investigations and initial report were by the consulting firm of Moran, Proctor, Mueser and Rutledge. The above listed committee reviewed the consultant's report and submitted their final report on Dec. 21, 1959 to state and local agencies.

From Santa Monica to Point Dume in Los Angeles County a bluff overlooks the Pacific Ocean. The top of the bluff is made up of outwash mesa material now cut by steep canyons. Elevation of bluff at edge varies from 125 to 275 ft.; elevation 1 mi. inshore ranges from 200 to 1,000 ft. Toe of slope meets a narrow beach which serves as route for Highway 101. The area covered by the report is 15 mi. long and 1 mi. wide and has had a long history of slides which have become a serious problem with increase of population.

Purpose of the study was 1) to establish reliability of causes and hazards of slides, and 2) a survey of methods of control, covering costs, feasibility, conclusions and recommendations.--J.E. Goffman.

15. MISCELLANEOUS

37. Pearl, Richard M. **GEOLOGY:** 260 p., illus., map, secs., diags., tables, New York, Barnes & Noble, 1960, approx. 125 refs.

This book, one of the College Outline Series, covers the introductory course in general geology, which is usually divided into one semester each of physical geology and historical geology. The organization of topics follows the usual one for college courses. It may thus be used as a supplement to any of the standard geology texts. The book should be useful to the advanced student reviewing the whole field of geology. It should also be valuable as a lab manual for classroom lectures, for adult study groups, and for individual programs of learning.--from pref.

Chapters cover the following subjects: science of geology, our planet earth, interior of the earth, volcanism, geologic structures produced by diastrophism, earthquakes, minerals, rocks, weathering and soils, gravity movements, streams, groundwater, glaciation, swamps and lakes, oceans, wind, tides, origin of the earth, evolution of life, interpretation of geologic history, Precambrian eras, Paleozoic era, Mesozoic era, Cenozoic era.

38. **GEOLOGY AT THE JAMBOREE:** *Geographical Magazine*, v. 5, no. 3, p. 12-15, 14 illus., Oct. 1960.

The Geology and Weather exhibit at the 5th National Boy Scout Jamboree held near Colorado Springs, Colorado, in July 1960, is described. It included separate displays devoted to weather, climate, topography, rocks, weathering and soils, fuels, minerals and metals, water, and archeology, each planned by a professional earth scientist.--M. Russett.

3-339. Woodbury, Angus M. **PROTECTING RAINBOW BRIDGE:** *Science*, v. 132, no. 3426, p. 519-528, 10 illus., map, Aug. 26, 1960.

In order to prevent the destruction or impairment of a national monument, a provision was included in a law passed in 1956 forbidding construction of a dam or reservoir within a national park or monument. This directly affects construction of a dam across Glen Canyon, Utah, which would impound water in the Rainbow Bridge monument area. Alternate sites, and protective dams and rerouted water channels have been suggested. Each of these has been diagrammed and described with its present effect on the monument and its possible future appearance. The author expresses the view that the impounded waters would not harm the monument nearly as much as all the projected protective tunnels and dams, which would scar the immediate area and bar overland access to the monument area as well. The use of water in arid regions is of great concern to those planning ahead for the future, as well as the preservation of scenic beauty; therefore it behooves conservationists to view such a project from a long-term utilization.--B.C. Schreiber.

3-340. American Geological Institute. **SUPPLEMENT TO THE GLOSSARY OF GEOLOGY AND RELATED SCIENCES.** Prepared by the Glossary Review Committee: 72 p., Washington, D.C., 1960.

This supplement contains 4,300 additions and revisions to the *Glossary of Geology and Related Sciences*, a cooperative project of the American Geological Institute, 1957. Two changes have been made in the form: 1) terms are capitalized only if they are proper nouns; 2) an attempt has been made to compose concise definitions for most terms (in the orig-

inal Glossary the practice of presenting quotations left many terms without clear definitions). References, where given, are to usages of a term, not necessarily to the original author or place of introduction.

3-341. Harrison, J.M. THE GEOLOGICAL SURVEY OF CANADA: Can. Mining Jour., v. 81, no. 8, p. 49-57, 10 illus., Aug. 1960.

The history and accomplishments of the Geological Survey of Canada are presented with supporting data on field programs, laboratory work, maps, reports, and education.

The prime task of the Survey, that of mapping and interpreting the geology of the country, is essential to the orderly and efficient development of Canada's natural resources. The immediate goal is to complete most of the reconnaissance geologic mapping of Canada's 3.8 million sq. mi. by 1970 or 1972; about half of the area remains to be covered.

In Spring as many as 90 field parties and a task force of several hundred geologists plus assistants begin their work in all 10 provinces and the territories. The widespread use of aircraft has resulted in the mapping of as great an area in 8 seasons as in the previous 110 years of the Survey's existence. Other field projects include aeromagnetic and seismic surveys, geochemical and ground water surveys, and special investigations in mineralogy, ore genesis, stratigraphic paleontology, and surficial geology.--W.C. Peters.

3-342. KENTUCKY GEOLOGIC MAP UNDERWAY: GeoTimes, v. 5, no. 4, p. 18-19, Nov.-Dec. 1960.

The newly instituted cooperative geologic mapping program of the state of Kentucky and the U.S. Geological Survey will utilize as many as 70 geologists, will entail production of 750 geologic maps at a scale of 1:24,000, and will ultimately cost about \$12,000,000 to be shared by the state and the federal government.

Three other cooperative programs with Kentucky are being carried on by the U.S. Geological Survey: a topographic survey, a surface and subsurface water resources study, and a study of the coal and clay areas of the state.--M. Russell.

3-343. West Virginia, Dept. of Mines. ANNUAL REPORT... 1959: 215 p., 4 illus., 8 tables, Charleston, [1960].

This report is a compilation of statistics and data on production, employment, and accidents for the underground, surface, auger, and quarry mines of West Virginia. Also included are statistics and data on oil and gas production. In 1959, 117,770,000 tons of coal were produced from 1,601 operations by 1,356 companies. Production of bee hive coke was 55,772 tons. Gas production of 746,478,773 cu. ft. daily initial open flow is reported from a total of 838 new wells.--M. Russell.

3-344. Vetter, Richard C. OCEAN-WIDE SURVEYS: GeoTimes, v. 5, no. 4, p. 12-13, 36, Nov.-Dec. 1960.

The most recently published chapter (9) of the twelve-chapter report "Oceanography 1960-1970" of the National Academy of Sciences (see abstract below) contains recommendations for ocean-wide surveys of great interest to geologists and geophysicists. The need for additional information on bathymetric,

gravimetric, and magnetic features of the deep sea floor is emphasized. The Mid-Atlantic ridge and SE. Pacific areas are recommended for high priority attention.--M. Russell.

3-345. National Academy of Sciences-National Research Council, Committee on Oceanography. OCEANOGRAPHY 1960 TO 1970. 9. OCEAN-WIDE SURVEYS: 22 p., 4 tables, Washington, D.C., 1960.

This chapter makes some suggestions for an international cooperative ocean-wide survey. The survey can be divided according to topics and distribution in space and time. The topics include: 1) shape of the bottom and the carpet of sediment; 2) geomagnetism, heat flow, gravity, seismic and crustal studies; 3) primary productivity, composition and distribution of plankton and the larger forms of marine life; and 4) distribution of water properties such as temperature, salinity, density, and sound velocity.

In order to chart and predict how these variables change with time we must determine the general average conditions, the seasonal variations, the secular variations, and the conditions over a large area at nearly the same time. To describe the ocean in terms of the above outline will require an extensive program of data collecting, sample collecting, recording of observations, analysis and distribution of data. Some research on the most efficient method of handling the data will be necessary.

The participation of different countries in a cooperative international effort of this magnitude should depend upon their resources and interest. In general, this discussion refers to the entire cooperative ocean-wide survey.

These sections in this report reflect present concepts of the types of measurements and general intensity of coverage needed. A strong recommendation is made for the formation of a continuing advisory committee to conduct a careful evaluation of objectives and means of carrying out the survey. Although our knowledge of the oceans is sparse it is good enough to tailor the survey to the special requirements of each area.--From p. 3-4.

This report deals with the following: proposed program (physical and chemical features, biological features, bottom features, geological features, navigation); division of responsibility between nations; intercalibration of methods and exchange data; publication of data; continuing advisory committee; estimated shiptime and manpower needed; recommended program for the United States; facilities; biological surveys.

3-346. Brereton, Roy G. LUNAR EXPLORATION: GeoTimes, v. 5, no. 3, p. 8-9, 27, 2 tables, Oct. 1960.

Lunar exploration will proceed through a series of probes: first by unmanned vehicles designed to impact on the moon, orbit the earth-moon system, orbit the moon, and soft-land an instrument package; and ultimately by a series of manned expeditions whose first objectives will be geological and environmental reconnaissance. Unmanned experiments will include studies or attempts in radiation, tracking and positioning, atmospheric pressure, photogrammetry, electron density, biology, trafficability, radio beacon, spectrograph, television photography, virology, and core sampling. Manned experiments will include geological reconnaissance, radiation, biological, virology, electric survey, seismic,

gravity, magnetic, meteor particles, temperature, and core samples. The first men on the moon should include a geologist, a physicist, and an engineer.--M. Russell.

3-347. American Society of Photogrammetry. **MANUAL OF PHOTOGRAPHIC INTERPRETATION:** 68 p., approx. 600 illus. (incl. col.), maps, diag., Washington, D.C., 1960, refs.

A manual prepared by approximately 80 contributing authors and edited by Robert N. Colwell. It describes principles and applications of photo interpretation in various natural sciences, and in agriculture, forestry, engineering, hydrology, etc. Contents are as follows:

Chap. 1. The Development of Photo Interpretation. Author-Editor: Robert S. Quackenbush, Jr.

Chap. 2. Procurement of Aerial Photography. Author-Editor: Robert N. Colwell.

Chap. 3. Fundamentals of Photo Interpretation. Author-Editor: Ellis L. Rabben.

Chap. 4. Photo Interpretation in Geology. Author-Editor: Benjamin A. Tator. This paper is separately abstracted below.

Chap. 5. Photo Interpretation of Soils. Author-Editor: Robert E. Frost.

Chap. 6. Photo Interpretation in Engineering. Author-Editor: Donald J. Belcher.

Chap. 7. Photo Interpretation in Forestry. Author-Editor: Richard C. Wilson.

Chap. 8. Photo Interpretation in Wildlife Management. Author-Editor: Daniel L. Leedy.

Chap. 9. Photo Interpretation in Range Management. Author-Editors: Charles A. Joy and Robert W. Harris.

Chap. 10. Photo Interpretation in Hydrology and Watershed Management. Author-Editor: Paul J. Zinke.

Chap. 11. Photo Interpretation in Agriculture. Author-Editors: Elon H. Bomberger and Henry W. Dill, Jr.

Chap. 12. Photo Interpretation in Urban Area Analysis. Author-Editor: James R. Wray.

Chap. 13. Photo Interpretation in Archaeology. Author-Editor: Ralph S. Solecki.

Chap. 14. Photo Interpretation in Geography. Author-Editor: John H. Roscoe.

Chap. 15. Special Forms of Photo Interpretation. Author-Editor: Callie H. Luckermann.

Chap. 16. Education and Training in Photo Interpretation. Author-Editor: Ted A. Cheney.

3-348. Tator, Benjamin Almon. **PHOTO INTERPRETATION IN GEOLOGY** (In: American Society of Photogrammetry. Manual of Photographic Interpretation: p. 169-342, 135 figs. incl. illus., maps, diag., 1960) approx. 1,400 refs.

A chapter in the Manual of Photo Interpretation (see above). It does not present an exhaustive treatment of the many-faceted subject photo interpretation in geology. It is a compilation of diverse aspects of geological photo interpretation by the con-

tributing authors, along with a degree of integration, with a voluminous literature dealing with this subject, and is not a cohesive textual treatment. The work is liberally referenced with the literature and the included photographic illustrations.

The major emphasis is on recognition of surface elements, including landforms and their relationship to earth structure and rock types. In order to meet the needs of readers of the manual who are not geologists, much simplified descriptions of the processes of development of landform types, rock structures, and earth structures are given. There are sections dealing with geomorphology; lithologic and stratigraphic interpretation; structural geology, including fracture and lineament analysis; methods of photogeology, including determination of strike and dip and structure contouring; and photo interpretation procedures for geological mapping. A sizeable listing of the literature of photogeology and related subjects is contained in a partly annotated bibliography.--Auth.

3-349. Leighton, Freeman Beach. **UNDERGRADUATE RESEARCH ON LANDSLIDES AT WHITTIER COLLEGE:** GeoTimes, v. 5, no. 3, p. 10-11, illus., Oct. 1960.

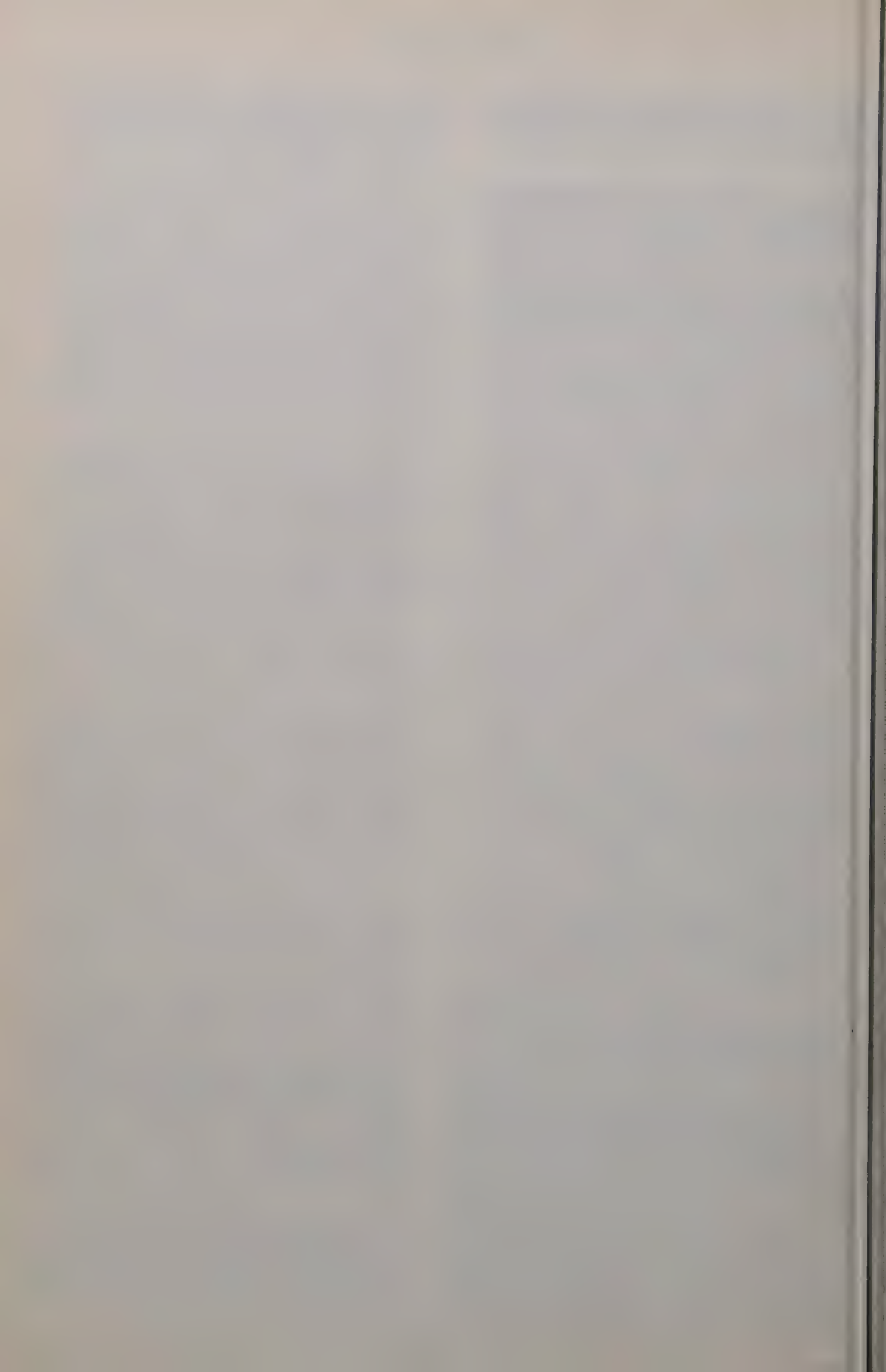
Five undergraduate students participated on a trial basis in a research project, sponsored by the National Science Foundation at Whittier College, on landslides in the Puente Hills, Whittier, California. The results confirm that this is an effective method of introducing superior undergraduates to the scientific method, and a similar program is planned for the remaining 3 years of the landslide project.--M. Russell.

3-350. Smith, Neal J. **OIL MAN LOOKS AT THE USSR:** GeoTimes, v. 5, no. 4, p. 8-11, 38, 6 illus., Nov.-Dec. 1960.

A delegation of 10 American oil specialists toured more than 7,000 mi. in the U.S.S.R., visiting 4 refineries, 4 oil fields, and numerous institutes, committees, and councils. Some general impressions were that exploration and production seem adequate to permit fulfillment of the goal of 4,750,000 barrels of oil by 1965, that refineries are inefficiently run but do the job required, that research facilities are in general poor but are staffed by high-calibre personnel, and that the economics of oil production in the U.S.S.R. are geared almost solely to meeting the requirements of an arbitrary plan.--M. Russell.

3-351. **НЕ ТОЛЬКО КОСТРЫ И ПОХОДЫ... OR A SOVIET FIELD GEOLOGIST SEES RED:** GeoTimes, v. 5, no. 4, p. 32-33, Nov.-Dec. 1960, ref.

A Soviet geologist [A. Borodyansky] complains that the equipment supplied parties working in Yakutia is inadequate for the task. Geophysical equipment, airphotos, mineralogical test equipment, clothing, and pack gear are specifically cited as being substandard.--M. Russell.



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